

A Formal Semantic Analysis of the Progressive

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To my Dad

Declaration

I declare that this thesis has been composed by myself and that the research reported therein has been conducted by myself unless otherwise indicated.

Edinburgh, October 1988.

A handwritten signature in black ink, reading "A Lascarides." The signature is written in a cursive style with a large, stylized initial "A".

Alex Lascarides

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Thanks are primarily due to my supervisor Barry Richards, who showed continuing willingness to debate the issues. Any coherence that occurs in this thesis is due in no small respect to him. Robin Cooper, Marc Moens and Jon Oberlander have also been particularly helpful, and my thanks go to them for reading the endless drafts of this thesis. I am also grateful to David McCarty and Mark Steedman who have helped me to clarify a few of the ideas presented here.

Finally, I would like to record my gratitude to the Economic and Social Research Council for providing me with a studentship that enabled me to carry out the research in this thesis.

And to Guy: Beep!

Abstract

Formal semantics constitutes the framework of this thesis, and the aim is to characterise the semantics of the progressive, as it appears in sentence (1).

- (1) Max was running towards the station

Among the problems is one known as the "imperfective paradox". According to intuitions, sentence (1) entails (2), but no entailment holds between (3) and (4).

- (1) Max was running towards the station
(2) Max ran towards the station
(3) Max was running to the station
(4) Max ran to the station

Since (1) and (3) would seem to have the same logical form, they ought to have similar entailments. Why is this not so?

This thesis is divided into two parts. The first part, containing chapters 2 to 5, evaluates the current formal theories that tackle the imperfective paradox. Solving the imperfective paradox consists of two tasks: the first is to characterise a semantic distinction between (2) and (4), and the second is to supply a semantic analysis of the progressive that is sensitive to this distinction and so results in a solution to the imperfective paradox. According to how the current theories tackle these two tasks, they can be classified into *three* camps which I will name as follows: the *Heterogeneous Strategy* (adopted by Dowty, Taylor and Cooper) provides one approach for fulfilling the first task, the *Eventual Outcome Strategy* (adopted by Dowty, Cooper and Hinrichs) provides an approach for defining the semantics of the progressive, and the *Event-based Strategy* (adopted by Parsons and Bach) provides a further alternative for achieving the two tasks at hand. All these strategies are intuitively motivated, but we will argue that they are ultimately untenable. The Heterogeneous Strategy and the Event-based Strategy fail to mesh with the treatment of point adverbials such as "At 3pm", and the Eventual Outcome Strategy produces a definition of the progressive that is viciously circular. Thus although the current theories that tackle the imperfective paradox are highly intuitively motivated, we will ultimately show that the formulations of these intuitions give rise to conflicts and tensions when it comes to explaining the natural language data.

The second part of the thesis, containing chapters 6 and 7, offers a new approach for tackling the imperfective paradox. This new approach invokes two tools; the interval-based temporal logic IQ (Richards 1986), and Moens' (1987) event-based AI model of temporal reference. IQ is an interval-based temporal logic with several innovations. First, unlike the previous interval-based theories, IQ maintains a high level of *homogeneity*: an atomic sentence is true at an interval I only if it is true at all subintervals of I. Second, IQ offers a technique whereby temporal expressions can have representations that receive their semantic interpretation with respect to *context*.

We use the roles of homogeneity and context in IQ to characterise the semantics of aspect, where the characterisation is based on Moens' model. This provides an arena in which to tackle the imperfective paradox anew. We explain the entailment between (1) and (2), and at the same time explain why no entailment holds between (3) and (4). Furthermore, we overcome the problems concerning the treatment of adverbials such as "At 3pm" that are encountered in the Heterogeneous Strategy and the Event-based Strategy, and, since we do not adopt the Eventual Outcome Strategy in defining the progressive, we overcome that strategy's problem of circularity. Hence our solution to the imperfective paradox will provide answers to the puzzles posed in the earlier chapters of the thesis.

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Chapter 1

The Progressive and the Imperfective Paradox

1 Aims

The research pursued in this thesis fits into a programme the aim of which is to supply the formal semantics of natural language. The assumption underlying this venture is that the meaning of a given sentence can be characterised by defining all its possible logical consequences. The particular task is to supply a formal semantic analysis of the progressive, as it appears in sentence (1).

- (1) Max was running towards the station

Among the problems is one known as the "imperfective paradox". According to intuitions, sentence (1) entails (2), but no entailment holds between (3) and (4).

- (1) Max was running towards the station
(2) Max ran towards the station
(3) Max was running to the station
(4) Max ran to the station

Since (1) and (3) would seem to have the same logical form, they ought to have similar entailments. Why is this not so?

The imperfective paradox has serious implications for more general questions concerning natural language, for example the relationship between syntax and semantics. The progressive involves a *uniform syntactic* operation, and so from the perspective of formal semantics, one would expect it to be related to a *uniform semantic* operation. But (1) and (3) have *different semantic* import. The problem is: how can the uniformity of the progressive in syntax be squared with its semantic 'irregularity'?

Answers to questions (a) and (b) are desiderata for solving the imperfective paradox.

- (a) How can we characterise the semantic distinction between (2) and (4), which is revealed in natural language by their different behaviours with the progressive?
(b) How should the progressive itself be characterised, so that it is sensitive to the semantic distinction between (2) and (4) and results in a solution to the imperfective paradox?

Answers to (a) and (b) should supply an answer to (c).

- (c) Which semantic features of a non-progressive sentence determine its relationship to the corresponding progressive form?

Our aim is to solve the imperfective paradox. We want a *principled* solution that meshes with a theory of other temporal phenomena, and to this end, we will *not* in some cases be evaluating previous solutions to the imperfective paradox ‘head on’, but may sometimes evaluate how that solution fits together with an account of other temporal expressions. We will do this in order to tease out the essential reasons why these accounts fail, and thus also the essential characteristics that should be embodied in the alternative theory.

The thesis can be divided into two parts. The first part, containing chapters 2 to 5, evaluates the current formal theories that tackle the imperfective paradox. These formal theories are, in the main, highly intuitively motivated. We will show, however, that the formulations of the intuitions give rise to conflicts and tensions when it comes to explaining the natural language data. This, in fact, is a central theme in the thesis. The second part of the thesis, containing chapters 6 and 7, offers a new approach for tackling the imperfective paradox. This new approach will offer answers to the puzzles posed in the first part of the thesis.

2 The Distinction Between (2) and (4)

The first problem connected with the imperfective paradox is that of specifying the semantic difference between (2) and (4).

- (2) Max ran towards the station
(4) Max ran to the station

How is this to be achieved?

One might want to place this task within a larger setting. There is a long tradition of work, usually associated with Vendler (1967), in which linguistic expressions are divided into *aspectual classes* according to their different temporal behaviours. The strategy is to invoke *metaphysical* distinctions between the classes. In the case of (2) and (4), there are different underlying metaphysical structures, which are meant to explain their different temporal behaviours.

Vendler divides verb phrases into four aspectual classes: activities, accomplishments, achievements and states. *Activities* (cf. “run towards the station”, “walk”) are processes in time, each part of which is itself a process. In contrast, *accomplishments* (cf. “run to the station”, “write a thesis”)

are more than processes; they essentially involve a 'conclusion' or 'culmination'. Thus any part which doesn't include the 'culmination' cannot be an accomplishment. *Achievements* (cf. "win a race", "reach the summit") also invoke a culmination point, but they differ from accomplishments in that they do not invoke a 'prior' process to the culmination. *States* (cf. "love Mary", "know the answer") can occur over a period of time, but they are not processes.

Sentences (2) and (4) have distinct underlying metaphysical structures, in that the former is an activity and the latter is an accomplishment. So in Vendler's terminology, the imperfective paradox can be restated in the following way: the progressive form of a sentence denoting an activity entails the corresponding non-progressive form, but this is *not* the case for accomplishments¹.

One strategy, then, for characterising a semantic distinction between (2) and (4) could be to formulate Vendler's *metaphysical* theory on the classification of aspect into a *semantic* environment. The result, of course, may or may not be relevant to a definition of the progressive. Vendler does not provide any clues as to how to define the semantics of the progressive itself. He merely gives us one strategy for achieving the first task connected with the imperfective paradox; i.e. maintaining a semantic distinction between (2) and (4). It remains to be seen whether the result is a semantic distinction that can form the foundations of a definition of the progressive that accounts for the imperfective paradox.

A formal characterisation of Vendler's classification of aspect has been attempted within the framework of interval-based semantics. In these theories, the truth of a sentence is defined relative to an interval of time. Using this framework, one could capture Vendler's claim that an accomplishment such as (4) occurs over an interval of time.

(4) Max ran to the station

If (4) is true at an interval I, then there is an interval J earlier than I where the tenseless sentence "Max runs to the station" is true; this reflects the idea that the accomplishment occurs over the interval J².

¹ This is not quite how Vendler would have put it, since he was concerned with the aspectual classification of *verb phrases* and not *sentences*. However, as Verkuyl (1972) and Dowty (1972), and Vendler himself in a footnote observe, the subject noun phrase can affect the aspectual classification, and therefore Vendler's classification must be one of whole sentences. In addition to accomplishment sentences, there are some sentences denoting *achievements* where the progressive form does not entail the corresponding non-progressive form. This is glossed over for now, but shall be returned to later.

² We have assumed here, as Dowty (1979) does, that "Max runs to the station" is a tenseless sentence, i.e. its representation will not invoke a tense operator. This sentence intuitively has a habitual reading: i.e. Max has the *disposition* of running to the station (every morning, say). But since we classify "Max runs to the station" as tenseless, it can have an accomplishment reading, in order that the past tense may operate on it to produce an accomplishment reading of (4).

Suppose that the interval-based framework is *heterogeneous*. That is, a sentence A may be true at the interval I and *false* at *subintervals* of I. This allows for the possibility that "Max runs to the station" is true at J, and false at K where K is a subinterval of J; this reflects exactly Vendler's claim that not every part of an accomplishment is itself an accomplishment. On the other hand, the truth of "Max runs towards the station" at an interval J may entail its truth at all subintervals of J (up to a certain limit in size); this reflects Vendler's claim that every part of a process (up to a certain limit in size) is itself a process. Hence heterogeneity provides the foundations on which to build semantic distinctions between (2) and (4) which reflect Vendler's metaphysical distinctions between them. So this strategy of invoking a heterogeneous interval structure, which I call the *Heterogeneous Strategy*, supplies the tools for formulating Vendler's classification of aspect³.

Inspired by the heterogeneous interval-based frameworks of Cresswell (1977) and Bennett and Partee (1972), Dowty (1979, 1986) follows the Heterogeneous Strategy to provide a semantic interpretation of the classification of aspect. For Dowty, sentences denoting activities and accomplishments are true only at intervals larger than the minimal (i.e. smallest) ones (and hence are heterogeneous). This is intended to capture Vendler's metaphysical claim that activities and accomplishments describe processes that *take time*. Dowty's representation of accomplishments differs from that of activities, in that the truth value at an interval I of a sentence denoting an accomplishment is determined by what happens at the *endpoints* of I, i.e. the culmination points. This is not the case for activities.

The Heterogeneous Strategy will be examined in detail in chapter 2. I shall argue that heterogeneity cannot yield a satisfactory semantic characterisation of point adverbials, like "At 3pm" in the sentences (5) and (6) (the natural meanings of these sentences will be discussed in chapter 2).

- (5) Max ran at 3pm
- (6) Max won the race at 3pm

It will thus be shown that the Heterogeneous Strategy is not satisfactory. One needs to represent a semantic distinction between sentences of different aspectual classes by some other means. The puzzle is: how else may one formulate the classification of aspect, so as to characterise the semantic distinctions between (2) and (4)?

³ In chapter 2, we will offer a more general version of the Heterogeneous Strategy, that relates to event-based frameworks as well as interval-based ones.

- (2) Max ran towards the station
- (4) Max ran to the station

3 The Definition of the Progressive

So far, we have discussed one strategy for characterising semantic distinctions between (2) and (4). The next question connected with the imperfective paradox is: can a unified semantics be formed of the progressive? Given the semantic distinctions between (2) and (4), Dowty is still stuck with the problem of explaining why (3) does not entail (4).

- (3) Max was running to the station
- (4) Max ran to the station

To do that, Dowty introduces the notion of *inertia worlds* in the definition of the progressive. This is meant to capture the following intuition: sentence (7) is true if the *eventual outcome* is that Max is the winner of the race, provided the current state of affairs (whatever that is) 'continues without interruption'.

- (7) Max is winning the race

Dowty's semantics for the progressive does not invoke conditions that concern what is going on now, instead they concern the *eventual outcome* of what is going on now. I call this strategy of defining the progressive the *Eventual Outcome Strategy*. In addition to Dowty (1979), this strategy has been adopted by Hinrichs (1983) and Cooper (1985).

The definition of the progressive under the Eventual Outcome Strategy involves *modality* of the 'counterfactual' kind, because one has to look at what *would* happen *if* the current actions 'continue uninterrupted'. Dowty introduces inertia worlds to define the appropriate notion of modality, i.e. an explanation of the phrase "if the state of affairs continues uninterrupted".

The motivation behind the Eventual Outcome Strategy is to avoid placing conditions *directly* on the states of affairs that make sentence (7) true. There is an abundance of states of affairs that correspond to (7). (7) may be true when Max is ahead in the race and running the fastest, or Max may be third, but running faster than the athletes in first and second place. If Max has a good reputation as an athlete, then (7) may be true even if Max is last in the race, but his strategy for winning is going according to plan. The puzzle is: What is the common property among these states of

affairs, that makes sentence (7) true? The Eventual Outcome Strategy defines the common property as one of eventual outcome, the eventual outcome being the one described in the corresponding non-progressive sentence. The Eventual Outcome truth conditions of the progressive yield an interpretation of (7) that avoids talk about what Max is actually doing at the current time; his position in the race, how fast he is running and so on. Instead, the truth conditions of (7) concern only the eventual outcome of the current state of affairs.

In spite of intuitive motivation for the Eventual Outcome Strategy, I argue in chapter 3 that one cannot provide a satisfactory definition of the progressive in terms of eventual outcome. But how else may the progressive be defined, so as to avoid the imperfective paradox?

Intuitively, one can think of sentence (8) as denoting an event that can be divided into phases; it is a *process* which leads to a *culmination point*.

(8) Max won the race

The progressive sentence (7) refers to that process, but it does not assert that the culmination occurs. This is the intuition underlying what I will call the *Event-based Strategy* in defining the progressive. Event-based theories of tense and aspect construct *event ontologies* to take into account the internal structure of events (Bach 1986, Hinrichs 1985, Moens 1987, Parsons 1984, ter Meulen 1982, 1984). They try to account for the imperfective use of the progressive by specifying the relation that holds between the incomplete event (as described by the progressive) and the complete event (as described by the simple past sentence). So what is called for is an ontology in which events can be decomposed into their constituent parts or assembled into more complex events.

According to event ontologists, accomplishments constitute a process and a culmination point. The *eventual outcome* of the process, provided it continues uninterrupted, is the culmination point. This structure is brought about by the way the *ontology* for events is set up. The event ontology thus provides the potential means to achieve one of the tasks connected with the imperfective paradox: defining the progressive. The event-based semantics of "Max was winning the race" will refer to the process that is assigned in the event ontology to (8)'s culmination.

Unlike the Eventual Outcome Strategy, the concept of a prior process (that is, a process that leads to a culmination) is *not* brought out purely by a *modal semantics* for the progressive. Instead, there are more ontological commitments: culmination points are assigned prior processes in the ontology. Hence constructing an event ontology provides a natural alternative to the Eventual

Outcome approach. The concept of eventual outcome that is defined explicitly in the *semantic* definition of the progressive under the Eventual Outcome strategy now appears as part of the the event *ontology*; i.e. it is one of the idiosyncratic things that is given as part of the model, rather than being defined in terms of rules.

Moreover, the Event-based Strategy provides an alternative to the Heterogeneous Strategy for distinguishing the semantics of (2) and (4). The Heterogeneous Strategy involves invoking a heterogeneous *interval* structure in order to formulate the classification of aspect. The Event-based Strategy does not do this. Instead, the distinct semantics of (2) and (4) is explained in the *event* ontology by assigning the underlying events different metaphysical structures. Thus the Event-based Strategy provides a way of fulfilling *both* of the tasks connected with the imperfective paradox: distinguishing the semantics of (2) and (4) and providing a definition of the progressive.

In chapter 4, I will examine the consequences of the Event-based Strategy. I will study Parsons' (1984) event-based solution to the imperfective paradox in detail. I will argue that Parsons' theory also fails to capture the semantics of point adverbials such as "At 3pm", as it appears in sentence (5).

(5) Max ran at 3pm

4 Our Solution to the Imperfective Paradox

We will present a new approach to solving the imperfective paradox that invokes two tools; the interval-based temporal logic developed by Richards and known as IQ, and Moens' event-based AI model of temporal reference.

IQ is an interval-based temporal logic with several innovations. It was originally designed to provide a formal semantic treatment of tense and temporal quantification in English (Richards 1986). The tenses in IQ are the three traditional logical tenses: past, present and future. The temporal quantifiers include frequency adverbials such as "always", "sometimes" and "exactly twice". IQ offers a technique whereby temporal expressions can have representations that achieve their semantic interpretation with respect to context. This technique allows Richards to achieve a Russellian interpretation of tense, where there is deictic reference to speech time, while maintaining a Priorean interpretation of temporal quantification, where there is reference to time, but not necessarily speech time. Thus IQ is innovative in that it combines the Russellian and Priorean accounts within a single formal framework. The theory of IQ is further developed in (Oberlander 1987a) and

(Oberlander 1987b), where several other applications of IQ to natural language are suggested.

IQ, unlike its predecessors such as (Dowty 1979), is an interval semantics which maintains a high level of *homogeneity* (which is the converse property to heterogeneity). That is, the truth values for the expressions of IQ are such that the definition of truth will yield the homogeneity property (9) for truth functional combinations of atomic sentences.

- (9) An atomic sentence A is true at an interval I only if A is true at all subintervals of I.

Because of the homogeneity property (9) that is part of the framework IQ, one cannot formulate in IQ the Heterogeneous Strategy: that is, one cannot assert that "Max runs to the station" is true at an interval I and false at subintervals of I. The question for us is: can homogeneity yield a semantic distinction between sentences (2) and (4), as a preliminary to solving the imperfective paradox?

This thesis presents the first theory on aspect that is given in a *homogeneous* interval-based framework. Using homogeneity, we represent semantic distinctions between sentences (2) and (4), where the underlying characterisation is based on Moens' (1987) classification of aspect. This is in sharp contrast to Dowty's *Heterogeneous* Strategy for providing semantic distinctions between sentences (2) and (4).

We build on the distinction between (2) and (4) in IQ with a definition of the progressive that is also based on Moens' model of temporal reference. The role context can play in logical form in IQ is used to reflect the role of context in Moens' model. This gives rise to another important original feature of this research: context plays a non-trivial role in characterising the semantics of aspect⁴. This provides an arena in which to tackle the imperfective paradox anew. One can explain the entailment from sentence (1) to (2), and at the same time explain why no such entailment holds between (3) and (4).

- (1) Max was running towards the station
- (2) Max ran towards the station
- (3) Max was running to the station
- (4) Max ran to the station

⁴ We take the position established by Kaplan (1977) and Kamp (1979), that the effect of context on the meaning of an utterance is an issue for semantics in certain cases, rather than pragmatics.

Furthermore, one is able to account for the natural meanings of (5) and (6) (the natural meanings of these sentences will be discussed in the subsequent chapters).

- (5) Max ran at 3pm
- (6) Max won the race at 3pm

Thus the solution to the imperfective paradox in IQ overcomes the inadequacies of the Heterogeneous Strategy, and the inadequacies of the current event-based theories. Moreover, our definition of the progressive is not subject to the problems concerning the Eventual Outcome Strategy, for it does not invoke a concept of modality.

5 What the Thesis does not Cover

There are many facets to the meaning of the progressive in English. This thesis concerns itself with just one of those facets; the imperfective paradox. I will largely ignore other natural language phenomena associated with the progressive. For example, I will not discuss futurate progressive sentences such as (10).

- (10) Max is leaving town tomorrow

I will also ignore the role of the progressive in discourse, which is discussed at length in (Kamp and Rohrer 1983) and (Dowty 1986). These researchers observe that the presence of the progressive can affect the temporal relations between events which are present in discourse. For example, discourse (11) is interpreted so that the event of Max arriving at the house occurs *before* the event of Mary running into the driveway.

- (11) Max arrived at the house. Mary ran into the driveway.

Discourse (12), on the other hand, demands that the time of the event of Max arriving at the house be *included* in the time when the progressive state holds.

- (12) Max arrived at the house. Mary was running into the driveway.

To explain these phenomena by building on our semantic representation of the progressive is a matter for further research. Oberlander (1987a) provides in IQ a representation of the so-called "simple present futurate" tense, as it appears in sentence (13).

(13) Max leaves town tomorrow

It would be interesting to see if his representation of the simple present futurate and our representation of the progressive can capture the meaning of sentences such as (10). Richards (1987) suggests how IQ may represent temporal connection in discourse. It would be interesting to see if our representation of the progressive and his strategy for representing temporal phenomena in discourse would yield an explanation of the difference between discourses (11) and (12). There is every indication that following this route would prove fruitful.

6 How the Thesis is Divided Up

In chapter 2, I will argue that the Heterogeneous Strategy for formulating the classification of aspect cannot yield natural interpretations of sentences (5) and (6).

(5) Max ran at 3pm

(6) Max won the race at 3pm

In chapter 3, I will argue against adopting the Eventual Outcome strategy in defining the progressive. I will demonstrate that a modal definition of the progressive cannot capture the intuitions we desire.

In chapter 4, I will study the consequences of the Event-based Strategy for solving the imperfective paradox. I will examine Parsons' (1984) formalisation of the Event-based Strategy, and argue that it falls short on the analysis of point adverbials, such as "At 3pm". He cannot account for the natural meaning of sentence (5).

In chapter 5, I will investigate the behaviour of the progressive with universally quantified noun phrases. I will show that Parsons' Event-based Strategy cannot account for these natural language data, while Dowty's Eventual Outcome Strategy in defining the progressive can. This yields a puzzle: how can one combine the Eventual Outcome Strategy's advantage on the analysis of these data with an account of the progressive that does not suffer its fatal flaws that are elucidated in chapter 3?

In chapters 6 and 7, I present a new account of aspect and aspectual taxonomy that features two innovations. First, the interval-based framework in which the account is stated is *homogeneous* and so is, potentially at least, not subject to the problems of adverbial modification encountered in heterogeneous theories. Second, *context* plays a non-trivial role in the semantic interpretation of

aspect and aspectual taxonomy. I solve the imperfective paradox in our theory. I will also show how one is able to give a satisfactory analysis of sentences (5) and (6), and thus our account will transcend the problems encountered in the Heterogeneous Strategy and the Event-based Strategy. The theory will also explain the natural language data introduced in chapter 5, demonstrating that the data can be explained without adopting the Eventual Outcome Strategy. Thus our solution to the imperfective paradox presented in chapters 6 and 7 will provide answers to the puzzles posed in the earlier chapters of the thesis.

Chapter 2

The Heterogeneous Strategy

1 Introduction

As I discussed in the previous chapter, solving the problem of the imperfective paradox consists of two tasks. The first is to represent a semantic distinction between sentences (1) and (2).

- (1) Max ran towards the station
- (2) Max ran to the station

The second is to provide a definition of the progressive that is sensitive to this distinction, and so results in a solution to the imperfective paradox. This chapter addresses the first task.

I mentioned in the previous chapter what I call the *Heterogeneous Strategy* for characterising a semantic distinction between (1) and (2). I will show how this strategy is formulated in the theories of Bennett (1981), Dowty (1979), Taylor (1977, 1985) and Cooper (1985), and I will argue that the strategy is ultimately untenable. The crucial test will be how the formulation of the Heterogeneous Strategy in the respective theories meshes with the treatment of point adverbials, such as "At 3pm".

It must be stressed that I am not looking at the semantics of the progressive in this chapter. I am discussing *only* the task of distinguishing the semantics of (1) and (2). Whatever distinction between these sentences one ends up with, it must not only fit with the definition of the progressive that solves the imperfective paradox, but it must also fit with a satisfactory analysis of temporal adverbials such as "At 3pm". I will be testing the Heterogeneous Strategy against the analysis of "At 3pm", and not against the analysis of the progressive.

2 Using Intervals

The task is to characterise a semantic distinction between (1) and (2).

- (1) Max ran towards the station
- (2) Max ran to the station

As discussed in the previous chapter, Vendler's (1967) classification of verbs provides clues for how

one might do this. Vendler divides linguistic expressions into *aspectual classes* according to their different temporal behaviours. The idea is to invoke *metaphysical* distinctions between the classes. In the case of (1) and (2), there are different underlying metaphysical structures which are meant to explain their different temporal behaviours. So one strategy for characterising a semantic distinction between (1) and (2) could be to formulate Vendler's *metaphysical* view on the classification of aspect within a *semantic* theory.

Vendler claims that an activity such as (1) and an accomplishment such as (2) both occur over an interval of time. This suggests that one should think about the semantics of (1) and (2) in terms of *intervals*. Some theories have attempted to formalise the classification of aspect by invoking an interval structure (Dowty 1979, Bennett 1981, Taylor 1977, 1985, Hinrichs 1985, Cooper 1985). Bennett and Dowty, for example, formalise the classification of aspect in an *interval-based* semantics: In their theories, the truth of a sentence is defined relative to an interval of time. Using this framework, one could capture Vendler's claim that an accomplishment such as (2) occurs over an interval of time. If (2) is true at an interval I, then there is an interval J earlier than I where the tenseless sentence "Max runs to the station" is true; this reflects the idea that the accomplishment occurs over the interval J.

Suppose that the interval-based framework is *heterogeneous*. That is, the truth of a sentence A at the interval I does *not entail* its truth at subintervals of I. This allows for a heterogeneous analysis of "Max runs to the station": i.e. one where "Max runs to the station" may be true at J and false at K where K is contained in J. This reflects exactly Vendler's claim that not every part of an accomplishment is itself an accomplishment. On the other hand, heterogeneity permits a 'homogeneous' analysis of certain classes. The truth of "Max runs" at an interval J may entail its truth at all subintervals of J (up to a certain limit in size); this reflects Vendler's claim that every part of a process (up to a certain limit in size) is itself a process.

Inspired by the heterogeneous interval-based frameworks of Cresswell (1977) and Bennett and Partee (1972), Dowty (1979) and Bennett (1981) use heterogeneity to provide a semantic characterisation of Vendler's aspectual classes. Dowty's representation of accomplishment sentences differs from that of activities, in that the truth value at an interval I of a sentence denoting an accomplishment is determined by what happens at the *endpoints* of I, i.e. the culmination points⁵. This is not the case for activities. In the case where the endpoints of an interval I satisfy the truth conditions

⁵ This analysis of accomplishments arises from the way Dowty analyses *achievements*. The analysis of achievements will be discussed in detail in subsequent sections of this chapter.

for an accomplishment sentence A, whereas the endpoints of an interval J contained in I do not, A will be true at that interval I and false at the interval J contained in I. In other words, Dowty's analysis of accomplishments is *heterogeneous*.

Bennett (1981) presents the distinction between sentences denoting accomplishments and those denoting activities as one between open and closed intervals. Bennett defines sentences denoting atelic events (activities and states) as true only on open intervals: this captures Vendler's idea that activities do not invoke culminations (so they do not have definite endings). On the other hand, telic events (accomplishments and achievements) are true only on closed intervals. This is meant to reflect Vendler's idea that accomplishments and achievements invoke culminations (so they have definite endings). Bennett's analysis of sentences denoting atelic events is *heterogeneous*: For suppose a sentence A denotes an atelic event, and let A be true at the interval I. We know that A is *false* at every closed interval, and so A is false at every closed interval contained in I. Thus A is true at I and false at certain subintervals of I, i.e. the closed intervals, and so the analysis of A is *heterogeneous*. A similar argument shows that Bennett's analysis of sentences denoting *telic events* is heterogeneous.

I call the strategy for characterising the semantics of aspectual classes by using a heterogeneous interval structure the *Heterogeneous Strategy*. This general strategy has been formulated in three different ways. We have briefly explained how Dowty and Bennett use the strategy in an *interval-based* semantics. In addition, Taylor (1977, 1985) formulates the strategy in an *event-based* framework that also invokes *intervals*, and Cooper (1985) formulates the strategy within the realm of *situation semantics*.

Taylor assigns predicates an argument place that is reserved for intervals of time. For example, the predicate "build" is a three-place predicate, taking as its arguments a builder, what he built, and the time taken up for building. Taylor defines *postulates* for predicates from the different aspectual classes that characterise the kinds of intervals that the predicates can take as arguments. For example, the postulates assert that if the formula $\text{build}(\text{max}, \text{house}, I)$ ("Max builds a house over the interval I") is true, then $\text{build}(\text{max}, \text{house}, J)$ is false if J is contained in I. This reflects Vendler's idea that no part of an accomplishment is itself an accomplishment. On the other hand, the postulates stipulate that if an activity such as $\text{run}(\text{max}, I)$ ("Max runs over the interval I") is true, then $\text{run}(\text{max}, J)$ is true for all intervals J (up to a certain limit in size) that are contained in I. This reflects Vendler's idea that every part of a process (up to a certain limit in size) is itself a process. Taylor is invoking a *heterogeneous* interval structure to analyse the aspectual classes. His representation of "build" is heterogeneous because if the formula $\text{build}(\text{max}, \text{house}, I)$ is true then

build(max,house,J) is false where J is contained in I. Hence Taylor is following the Heterogeneous Strategy for interpreting the aspectual classes⁶.

Cooper (1985) provides a further formulation of the Heterogeneous Strategy for characterising the semantics of expressions from different aspectual classes, this time within the framework of *situation semantics*. Individuals, relations and locations constitute the primitive objects of Cooper's semantic framework. Locations play the role of intervals of time. One constructs *facts* from these primitive objects: the fact $\langle l, r, x_1, \dots, x_n, \text{true} \rangle$ is interpreted as "the relation *r* holds of individuals x_1, \dots, x_n over location *l*".

Cooper offers a series of *postulates* which describe the *kinds* of locations that facts from the different aspectual classes can take as arguments. For example, the postulates stipulate that if a history (i.e. a set of facts) contains the accomplishment fact $\langle l, \text{build}, \text{max}, \text{house}, \text{true} \rangle$ (i.e. Max builds a house over location *l*), then it does *not* contain the fact $\langle l', \text{build}, \text{max}, \text{house}, \text{true} \rangle$ for any location *l'* contained in *l*. This is a heterogeneous interpretation of accomplishments, and reflects Vendler's idea that no part of an accomplishment is itself an accomplishment. On the other hand, Cooper's postulates assert that if a history contains the activity fact $\langle l, \text{run}, \text{max}, \text{true} \rangle$ (i.e. Max runs over location *l*), then it also contains the facts $\langle l', \text{run}, \text{max}, \text{true} \rangle$ for every location *l'* contained in *l*; this reflects Vendler's idea that every part of a process is itself a process.

Although Cooper's and Taylor's theories are stated in different frameworks, they are strikingly similar. The kinds of *locations* that accomplishments and activities can take as arguments according to Cooper's postulates are equivalent to the kinds of *intervals* that they can take according to Taylor's postulates.

3 Testing the Heterogeneous Strategy

We have reviewed three different ways in which to formulate the Heterogeneous Strategy for distinguishing among linguistic expressions of different aspectual classes, associated with Dowty and Bennett, Taylor and Cooper respectively. In order to examine the implications of the Heterogeneous Strategy, let us evaluate Dowty's formalism. The consequences of this evaluation can be

⁶ Hinrichs' (1985) theory on the classification of aspect is similar to Taylor's. Like Taylor's, Hinrichs' framework is Davidsonian, and his representations of verbs feature an extra argument place reserved for spatio-temporal *locations*, where locations in Hinrichs' theory play the same role as intervals in Taylor's theory. This extra argument place can be thought of as identifying those locations at which the given event takes place. Hinrichs' analysis of "build" is *heterogeneous* like Taylor's, for his theory incorporates a postulate that if build(max,house,*l*) is true for a location *l*, then there is no location *l'* contained in *l* such that build(max,house,*l'*) is true.

shown to carry over to the other two approaches.

The following is an example of the imperfective paradox: (3) entails (4), but no entailment holds between (5) and (6).

- (3) Max was running
- (4) Max ran
- (5) Max was winning the race
- (6) Max won the race

So in order to solve the imperfective paradox, Dowty must characterise a semantic distinction between the *activity* sentence (4) and the *achievement* sentence (6).

A basic desideratum for the analyses of (4) and (6) is that they should fit with a representation of temporal adverbials, for example the point adverbial "At 3pm" as it appears in sentences (7) and (8).

- (7) Max ran at 3pm
- (8) Max won the race at 3pm

I will argue in this chapter that the Heterogeneous Strategy for interpreting the aspectual classes cannot yield a satisfactory analysis of these sentences.

The natural interpretation of (7) is an *inchoative* one; Max *starts* to run at 3pm. The natural interpretation of (8) is a *terminal* one; Max crosses the finish line in first place at 3pm. To capture these interpretations in the *semantic* characterisations of (7) and (8) would be a somewhat controversial thing to do, since it would entail that (7) is false unless Max starts to run at 3pm, and (8) is false unless Max crosses the finish line at 3pm. I will nevertheless assume that this is what is required, since these interpretations of (7) and (8) are not cancellable⁷. How can we capture this data in Dowty's semantic theory?

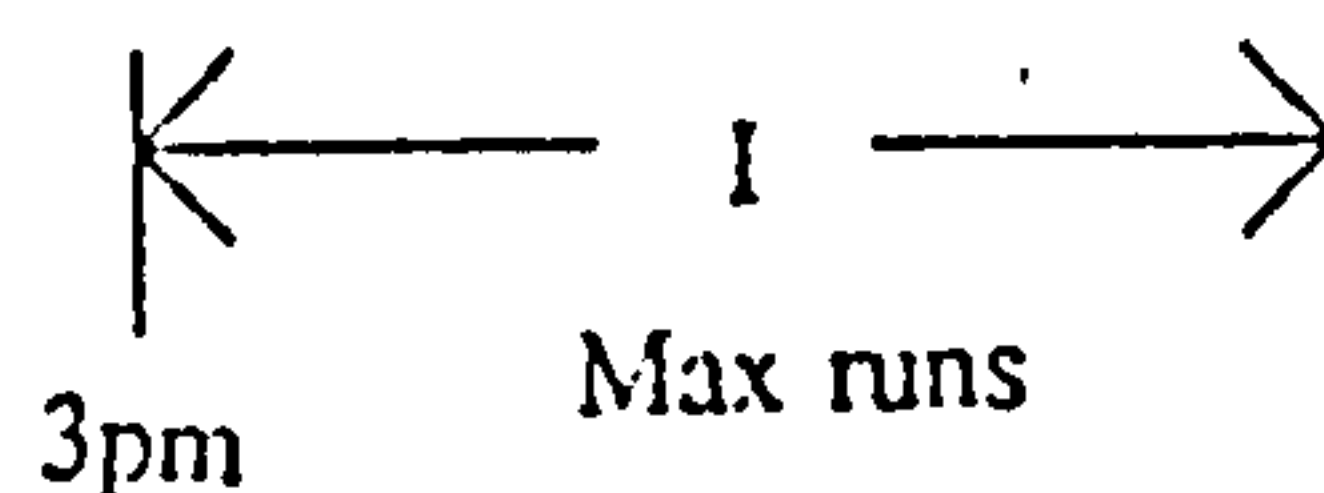
⁷ According to intuitions sentences (a) and (b) are strange, whatever the context.

- (a) ?Max ran at 3pm, and he started to run at 2pm
- (b) ?Max won the race at 3pm, and he crossed the finish line at 3:30pm

I choose to account for this by regarding these sentences as semantically unsatisfiable.

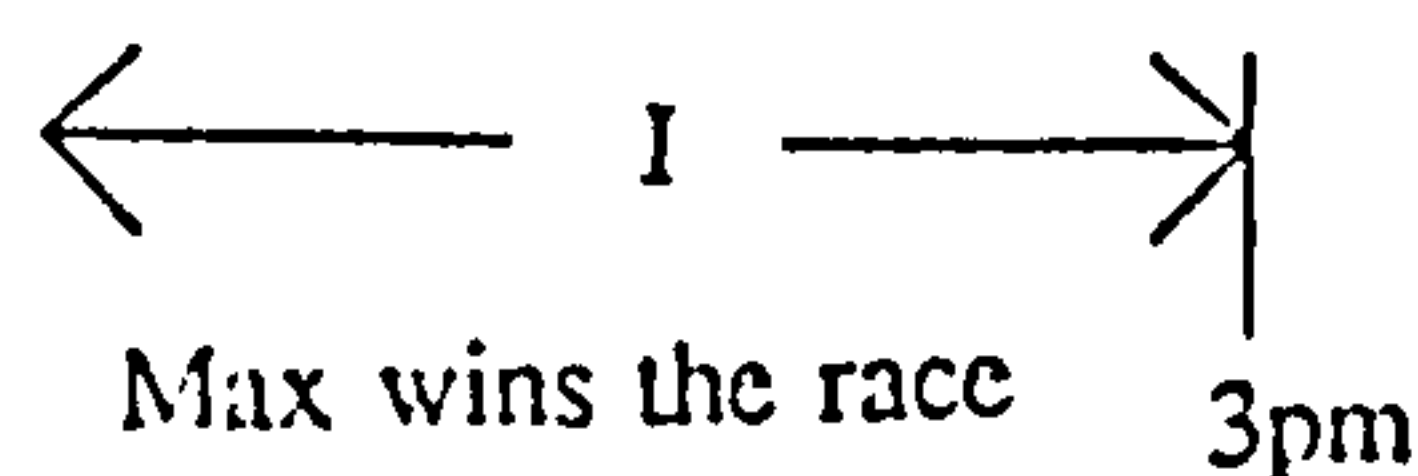
Dowty represents the point adverbial "At 3pm" as a sentential operator. Ignoring tense for now, the logical forms of (7) and (8) are represented with the schema $AT3pm(\Phi)$, where Φ is the logical form of "Max runs" or "Max wins the race"⁸. Since Dowty's framework is interval-based, the truth of Φ is defined relative to intervals. So the truth conditions of $AT3pm(\Phi)$ might relate the time 3pm to the interval I where Φ is true. The question is: what relation captures the natural interpretations of (7) and (8)?

Dowty represents the activity "Max runs" as true only on *non-minimal* intervals (i.e. intervals larger than a moment). The initial bound of the interval identifies the time Max *starts* to run. So to capture the natural interpretation of (7), its truth conditions must identify 3pm with the *initial bound* of the interval at which "Max runs" is true; i.e. it must have the following temporal structure, where I is an interval at which "Max runs" is true.



Given the logical form of (7), we obtain these desired truth conditions for (7) only if the truth of $AT3pm(\Phi)$ entails that 3pm is the *initial bound* of the interval I at which Φ is true.

Now consider the case of sentence (8). Dowty represents the achievement sentence "Max wins the race" as true only on non-minimal intervals. The *final bound* of the interval is interpreted as the time when the culmination occurs; in this case the culmination is that Max crosses the finish line in first place. So to capture the natural interpretation of (8), its truth conditions must identify 3pm with the *final bound* of the interval at which "Max wins the race" is true; i.e. it must have the following temporal structure, where I is an interval at which "Max wins the race" is true.



Given the logical form of (8), we obtain these desired truth conditions for (8) only if the truth of $AT3pm(\Phi)$ entails that 3pm is the *final bound* of the interval I at which Φ is true.

⁸ Φ represents present tensed sentences because Dowty assumes that the tenseless sentences are the present tensed ones. This is discussed in more detail later.

So, under the assumption that (7) and (8) both have logical form $AT3pm(\Phi)$ (ignoring tense for now), a tension arises in their truth conditions, in that (7) requires $AT3pm(\Phi)$ to entail the *initial bound* relation between 3pm and the interval I at which Φ is true, and (8) requires the *final bound* relation⁹.

Dowty's interprets activity and achievement sentences as true only on non-minimal intervals, and so "Max runs" or "Max wins the race" may be true at an interval I and false at an interval J which is contained in I, e.g. when J is a minimal interval. Hence Dowty's interpretation of activity and achievement sentences is heterogeneous. But Dowty's interpretation of these sentences gives rise to a tension between the logical representations of (7) and (8). The question now is: what implications does this tension have for heterogeneity?

In the subsequent sections of this chapter, I will demonstrate the tension between the representations of (7) and (8) in Dowty's and Taylor's theories, in order to examine the implications for heterogeneity.

We do not examine the tension with respect to Cooper's theory, because the logical forms of sentences (7) and (8) are not fully worked out in the framework of situation semantics. Given that the argument we present here hinges on establishing the logical forms of sentences (7) and (8), we could not formulate it in Cooper's framework. However, since Taylor's and Cooper's general approaches for interpreting the aspectual classes are closely related, it will be clear that the argument against heterogeneity that I formulate in Taylor's theory undermines Cooper's use of heterogeneity, *whatever* logical form he might assign to sentences (7) and (8)¹⁰. But first, I start with Dowty's theory.

⁹ One might feel uncomfortable with our desire to capture the inchoative interpretation of (7) in the semantics, despite the fact that this interpretation is not cancellable. However, if one accepts that the natural interpretation of (8) is a semantic one, which admittedly is open to debate, then even if the inchoative interpretation of (7) is demoted to pragmatics, there is still a tension in the truth conditions of $AT3pm(\Phi)$ required by sentences (7) and (8). Sentence (8) requires $AT3pm(\Phi)$ to be true only if 3pm is the *final bound* of the interval I at which Φ is true. Under these truth conditions, we would interpret (7) as true only if Max *finishes* running at 3pm. Whatever (7) means, it certainly does not mean that Max stops running at 3pm. Therefore we still have a tension between the truth conditions of $AT3pm(\Phi)$ required by (7) and the truth conditions of $AT3pm(\Phi)$ required by (8). In the rest of this chapter, however, for the sake of committing myself to a particular semantics for (7), I will maintain that the supposition that the *semantic* interpretation of (7) should be an inchoative one.

¹⁰ We will discuss Cooper's theory in detail in the next chapter, when we examine his strategy for defining the progressive.

4 Dowty's Heterogeneous Interpretation of the Aspectual Classes

Dowty characterises a semantic distinction between activity sentences, such as (9), and achievement and accomplishment sentences, such as (6) and (10), by formulating the metaphysical distinctions described by Vendler's (1967) classification of aspect in a heterogeneous interval-based semantics.

- (9) Max ran
- (6) Max won the race
- (10) Max built a house

In order to construct an interval-based semantic representation, Dowty is obliged to introduce definitions for intervals and related notions. Intervals are described as connected sets over the reals. The definitions of the related notions such as "subinterval" and "initial bound" conform to their intuitive correlates.

Dowty formulates Vendler's classification of verbs as follows: he postulates a single class of predicates, which are the *stative predicates* such as "is insane". His objective is to interpret verbs from all Vendler's aspectual classes as combinations of statives with explicitly interpreted operators. His strategy is to distinguish the logical forms of simple propositions, that are derived from verbs that belong to different aspectual classes.

Sentence (11) is an example of a simple stative sentence, whose logical form is the atomic formula (12).

- (11) Max is insane
- (12) insane'(Max')

The predicate "insane'" and the singular term "Max'" are primitive elements of the system; they are the units of meaning. Dowty's analysis of statives is *homogeneous*, i.e. they satisfy the converse principle to *heterogeneity*: if (12) is true at an interval I, then (12) is true at all subintervals of I. Activities, accomplishments and achievements are all derived from statives by the application of certain operators and connectives, which yield *heterogeneous* interpretations of these classes.

4.1 The Semantic Interpretation of Achievements

Dowty observes, in agreement with Kenny (1963), that an achievement always involves the coming about of a particular *state of affairs*. For example, sentence (13) involves the coming about of the state of affairs where Max is the winner of the race.

(13) Max won the race

In order to capture this observation, Dowty represents achievements with the aid of the operator BECOME. The logical form of tenseless achievements is given by (14), where Φ denotes the state of affairs once the achievement is completed.

(14) [BECOME Φ]

For example, the tenseless achievement (15) will have the logical form (15a), where $\text{winner}'(\text{max}', \text{race}')$ represents the state that Max is the winner of the race.

(15) Max wins the race

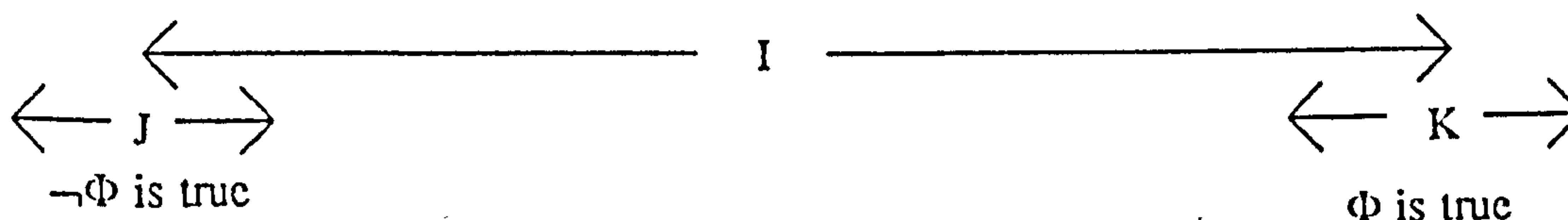
(15a) [BECOME ($\text{winner}'(\text{max}', \text{race}')$)]

The truth conditions for [BECOME Φ], where Φ is a formula, are given below:

The Truth Conditions for BECOME

[BECOME Φ] is true at an interval I if and only if there is an interval J containing the initial bound of I such that $\neg\Phi$ is true at J and there is an interval K containing the final bound of I such that Φ is true at K.

The truth of the sentence [BECOME Φ] requires the following temporal structure:



The truth value of [BECOME Φ] at the interval I depends on what goes on at the endpoints of I . The endpoints of an interval I may satisfy the truth conditions of [BECOME Φ], even though the endpoints of an interval I' contained in I do not satisfy the conditions. Therefore it is possible for [BECOME Φ] to be true at an interval I and *false* at an interval I' that is contained in I . So Dowty's analysis of achievement sentences is heterogeneous.

Note that achievement sentences can only be true at *non-minimal* intervals. By this I mean that they are only true at intervals larger than a *minimal* interval, or, in other words, a *moment*, which in Dowty's theory is a singleton set like $\{t\}$. For if [BECOME Φ] is true at a moment $\{t\}$, then both Φ and $\neg\Phi$ must be true at $\{t\}$. Therefore [BECOME Φ] is false at all moments for all Φ . Vendler claims that achievements are *punctual*, and yet Dowty's achievements are *false* at all moments. Therefore Dowty's heterogeneous analysis of achievement sentences does not conform exactly to Vendler's metaphysical description of them¹¹.

4.2 The Semantic Interpretation of Activities

The logical form of activities includes the operator DO, that takes a singular term and a stative as its arguments; the singular term is supposed to denote the *agent* of the activity. So the tenseless activity (16) has the logical form (16a), where "walking-state'(Max')" is a stative formula.

(16) Max walks

(16a) DO(Max', walking-state'(Max'))

Dowty does not give explicit truth conditions for the operator DO, but he does claim that the following postulate applies to activities.

(58) If A is an activity verb, then if $A(x)$ is true at an interval I , there is some physically definable property P such that the individual denoted by x lacks P at the lower bound of I and has P at the upper bound of I . (Dowty 1979:168)

Postulate (58) is supposed to capture the intuition that activities, such as "Max ran", involve an *indefinite change of state*¹². Note that if an activity $A(x)$ is true at the minimal interval $\{t\}$, then

¹¹ Dowty himself observes some undesirable consequences of his definition for the operator "BECOME", but his criticisms are not relevant for our purposes here.

¹² Without a clear account of what sort of properties P can be, the activity postulate (58) is uninformative. No such account is given by Dowty.

there must be a property *P* such that *x* lacks *P* at {*t*}, and *x* has *P* at {*t*}. Therefore it follows that activities are true only at non-minimal intervals. They are therefore *heterogeneous*, because an activity sentence may be true at an interval *I* and false at an interval *J* contained in *I*, e.g. when *J* is a *minimal* interval.

Given that activities are true only at non-minimal intervals, we are left with a question: what structure do these non-minimal intervals have? Dowty (1979) is somewhat vague on this issue, but in (Dowty 1986), he argues that an activity is true at an interval only if it is true at all subintervals *above a certain minimal size*. Postulate (58) in the 1979 framework leaves open the issue of whether activities conform to this.

5 Dowty's Analysis of Point Adverbials

I have now discussed the semantics of activity and achievement sentences in Dowty's theory. The semantics of these sentences make essential use of the heterogeneous interval structure. A basic desideratum for this analysis is that it must fit with an interpretation of temporal adverbials, such as the point adverbial "At 3pm" as it appears in sentences (7) and (8).

- (7) Max ran at 3pm
- (8) Max won the race at 3pm

I will now investigate how one might define "At 3pm". This will be the crucial test for Dowty's formulation of the Heterogeneous Strategy. I will show that one cannot account for sentences (7) and (8) given Dowty's heterogeneous interpretations of activity and achievement sentences.

5.1 The Logical Form

One must assign the *tenseless* sentences that include point adverbials their *logical forms*. Let us start with sentence (17)¹³.

- (17) Max wins the race at 3pm

The logical form of "Max wins the race" is sentence (15a).

¹³ Dowty assumes that the *tenseless* sentences are the present-tensed ones. So (17) is a *tenseless* sentence. Dowty's full definition of tense appears in appendix 2.

(15a) [BECOME (winner'(max',race'))]

Therefore given Dowty's structural representation of "At 3pm", there are two possible logical forms for sentence (17); (17a) or (17b)¹⁴.

(17) Max wins the race at 3pm

(17a) [BECOME [AT(3pm, (winner'(max',race'))))]]

(17b) [AT(3pm, [BECOME (winner'(max',race'))])]

5.1.1 BECOME with Wide Scope over AT

Suppose that the logical form of sentence (17) is sentence (17a).

(17a) [BECOME [AT(3pm, winner'(max',race'))]]

(17a) is true at the interval I if and only if there is an interval J containing the lower bound of I such that (18) is false at J, and there is an interval K containing the upper bound of I such that (18) is true at K.

(18) [AT(3pm, winner'(max',race'))]

According to Dowty's definition for "AT"¹⁵

[AT(t,Φ)] is true at I if and only if Φ is true at {t},

sentence (18) is an *eternal sentence*: it is either true at all intervals or false at all intervals. Suppose that (18) is true at all intervals. Then there is no interval J containing the lower bound of I such that (18) is false at J. So (17a) is false at I. On the other hand, suppose that (18) is false at all intervals. Then there is no interval K containing the upper bound of I such that (18) is true at K. So (17a) is false at I. Hence given the eternal nature of AT, sentence (17a) must always be false, contrary to common sense.

To rescue (17a) as the representation of (17), one might try to revise the analysis of AT so

¹⁴ The logical form Dowty chooses is (17b), but I will entertain both possibilities for now.

¹⁵ I have modified Dowty's definition of AT so that it is defined relative to intervals. His original definition of [AT(t,Φ)] entails that it is true or false simpliciter, and this does not conform with the interval-based framework.

that $[AT(t, \Phi)]$ is no longer an eternal sentence. We wish $[AT(t, \Phi)]$ to be true at some intervals and false at others. To achieve this, the truth conditions of $[AT(t, \Phi)]$ might have the following form, where R denotes some non-trivial relationship between t and I .

$[AT(t, \Phi)]$ is true at the interval I if and only if tRI , and Φ is true at I .

It must be stressed that in this definition of $[AT(t, \Phi)]$, we are using the expression " t " in two different ways. The expression " t " in the formula $[AT(t, \Phi)]$ is an expression in the *object language*, whereas the expression " t " that is related by R to I in the truth conditions is an expression in the *metalanguage*, and is denoted by the expression " t " in the object language.

What relationship is denoted by R ? One must investigate further the interaction between BECOME and AT.

The natural interpretation of sentence (17) is one in which Max is the winner of the race at 3pm, but not before. But "Max is the winner of the race" is exactly the state of affairs that corresponds to the formula $\text{winner}'(\text{max}', \text{race}')$. So (17) must be true only if $\text{winner}'(\text{max}', \text{race}')$ is (a) true at $\{3\text{pm}\}$ and (b) false at every non-minimal interval whose final bound is $\{3\text{pm}\}$. Condition (b) arises as a consequence of the *homogeneity* of states. If $\text{winner}'(\text{max}', \text{race}')$ were true at some non-minimal interval, however small, whose final bound was 3pm, then $\text{winner}'(\text{max}', \text{race}')$ would be true at some moment $\{t\}$ before 3pm. This would not be a situation in which sentence (17) is regarded as true.

Since the truth of $\text{winner}'(\text{max}', \text{race}')$ at $\{3\text{pm}\}$ must contribute to the truth of (18), the relation R must be defined so that $3\text{pm}R\{3\text{pm}\}$ is satisfied. On the other hand, if $\text{winner}'(\text{max}', \text{race}')$ is false at every interval whose final bound is 3pm, then $[AT(3\text{pm}, \text{winner}'(\text{max}', \text{race}'))]$ is also false at these intervals (by the above schema for the truth definition of $[AT(t, \Phi)]$).

Now consider the truth conditions for (17a) with these constraints on AT. (17a) is true at the interval I if and only if there is an interval J containing the lower bound of I such that $[AT(3\text{pm}, \text{winner}'(\text{max}', \text{race}'))]$ is false at J , and there is an interval K containing the upper bound of I such that $[AT(3\text{pm}, \text{winner}'(\text{max}', \text{race}'))]$ is true at K . Suppose that $\text{winner}'(\text{max}', \text{race}')$ is true at $\{3\text{pm}\}$ and false at every interval whose final bound is $\{3\text{pm}\}$. Then by the above constraints on AT, $[AT(3\text{pm}, \text{winner}'(\text{max}', \text{race}'))]$ is true at $\{3\text{pm}\}$ and false at every interval whose final bound is $\{3\text{pm}\}$. But then according to the truth conditions for BECOME, (17a) is true at *any* interval I whose final bound is $\{3\text{pm}\}$. This does not agree with the actual use of (17). So one cannot rescue (17a) as the representation of (17). So we have only one possible representation of (17) left, and

that is (17b).

(17b) [AT(3pm, [BECOME winner'(max',race')])]

5.1.2 BECOME with Narrow Scope over AT

How may (17b) yield a satisfactory analysis of (17)?

(17) Max wins the race at 3pm

(17b) [AT(3pm, [BECOME winner'(max',race')])]

Given Dowty's current definitions for BECOME and AT, the truth of (17b) requires that [BECOME (winner'(max',race'))] be true at {3pm}. But any formula of the form [BECOME Φ] is false at all moments (i.e. all intervals that are singleton sets). Hence sentence (17b) is always false, contrary to the use of (17).

In the case of (17b), we have encountered the same issue as we did for (17a): squaring the definitions of BECOME and AT. If (17b) is to be a satisfactory representation of (17) with Dowty's definition for BECOME, one must revise his definition of AT. Moreover, this definition must yield a satisfactory analysis of sentence (19).

(19) Max runs at 3pm

Since I am assuming that the logical form of sentence (17) is (17b), for the sake of uniformity the logical form of sentence (19) must be (19a).

(19a) [AT(3pm, [DO(max', running-state'(max'))])]

How may one modify Dowty's definition of AT so that (17b) and (19a) represent (17) and (19)?

5.2 The Eternal Nature of [AT(t, Φ)]

For the sake of perspective, I will now investigate how one might capture the meaning of sentence (19) in the truth conditions of (19a). As Dowty's definition of "AT" stands, sentence (19a) is true just in case [DO(max', running-state'(max'))] is true at the moment {3pm}. But (by postulate (58)) all sentences of the form [DO(a, Φ)] are false at all moments. Therefore sentence (19a) is

always false. If we are to preserve Dowty's interpretation of sentences denoting activities, we must modify the truth conditions for $[AT(t, \Phi)]$, so that the truth of $[AT(t, \Phi)]$ arises from the truth of Φ at some *non-minimal* interval I .

The question now is: at which intervals I does the truth of Φ contribute to the truth of $[AT(t, \Phi)]$? To answer this question, one might specify a relation R between the time t and the interval I . $[AT(t, \Phi)]$ is currently an *eternal sentence*: it is true at all intervals or at none. If we are to preserve the eternal nature of $[AT(t, \Phi)]$, then its new truth definition might follow the schema given below, where R expresses some relation between t and I .

$[AT(t, \Phi)]$ is true at an interval J if and only if there exists an interval I such that tRI , and Φ is true at I .

How should R be specified?

To answer this question, let us consider the representations of sentences (19) and (20).

(20) Max does not run at 3pm

I will now show that one cannot adequately represent both sentences (19) and (20) given the above schema for defining AT .

There are no scope ambiguities in the negation featured in sentence (20). Sentence (20) entails that at 3pm, Max does not run. To capture this in Dowty's theory, $\neg[AT(3pm, \Phi)]$ must be truth-conditionally equivalent to $[AT(3pm, \neg\Phi)]$, where Φ represents the sentence "Max runs". Therefore we can assume that the logical form of sentence (20) is (20a).

(20a) $[AT(3pm, \neg[DO(max', running-state'(max')])])]$

Let us now consider the truth conditions of sentence (20a). Since "Max runs" is an activity, the formula (21) is true at all moments (i.e. all intervals that are singleton sets).

(21) $\neg[DO(max', running-state'(max'))]$

In particular, (21) is true at $\{3pm\}$ in all models. But the relation R must be defined so that 3pm stands in the relation R to the interval $\{3pm\}$ (the justification for this was discussed in section 5.1.1). So since (21) is true at $\{3pm\}$, then (20a) must be true *at all intervals* - because of the eternal nature of AT - in all models.

But suppose that the relationship R in the truth conditions of $[AT(t, \Phi)]$ holds in a model M between 3pm and an interval I at which $[DO(\text{max}', \text{running-state}'(\text{max}'))]$ is true. (Notice that this assumption does *not* clash with the fact that $\neg[DO(\text{max}', \text{running-state}'(\text{max}'))]$ is true at $\{3pm\}$ and the assumption that $3pmR\{3pm\}$). Then (19a) is true in the model M *at all intervals*, due to the eternal nature of AT . But (19a) is the logical form of (19).

- (19) Max runs at 3pm
 (19a) $[AT(3pm, [DO(\text{max}', \text{running-state}'(\text{max}'))])]$

So in the model M , sentences (19) and (20) are both true at all intervals.

Here we have a paradoxical situation on our hands. We have constructed a model M such that sentences (19) and (20) are both true at all intervals with respect to M .

- (19) Max runs at 3pm
 (20) Max does not run at 3pm

This undesirable result arises from a clash between the assumption that activities take time (i.e. they are true only at non-minimal intervals), and the assumption that formulae of the form $[AT(t, \Phi)]$ are eternal sentences. If we are to preserve Dowty's analysis of the aspectual classes, it is necessary to relax the condition that $[AT(t, \Phi)]$ is an eternal sentence¹⁶. This can be achieved by defining the new truth conditions of $[AT(t, \Phi)]$ according to the following schema:

$[AT(t, \Phi)]$ is true at I just in case tRI and Φ is true at I

The revised definition of $[AT(t, \Phi)]$ involves expressing a relationship R between t and the interval I of *evaluation*. With this modification to $[AT(t, \Phi)]$, one guarantees that sentences (19) and (20) do not receive the same truth value at the same intervals in the same model.

We have seen the general schema that the truth conditions of AT must follow. There is still the task, however, of describing the relationship R so that it captures the desired analyses of sentences (7) and (8), whose logical forms are (7a) and (8a) respectively¹⁷.

¹⁶ The above argument that $[AT(t, \Phi)]$ cannot be an eternal sentence with Dowty's interpretation of activities applies to achievements as well. To preserve Dowty's claim that achievement sentences are true only at non-minimal intervals, one must revise his truth definition for AT so that the formulae $[AT(t, \Phi)]$ are not eternal sentences.

¹⁷ The representation of the past tense in (7a) and (8a) is Dowty's abbreviation for his analysis of tense to be found in appendix 2.

- (7) Max ran at 3pm
- (7a) [PAST + [AT(3pm, [DO(max',running-state'(max'))]]]]
- (8) Max won the race at 3pm
- (8a) [PAST + [AT(3pm, [BECOME winner'(max',race'))]]]

5.3 The Relation R in the Definition of [AT(t,Φ)]

How is one to express the relationship R between 3pm and I in the truth conditions for [AT(3pm,Φ)] at I? Let us first examine the constraints required on R in order that the representation of (7) captures its natural, inchoative meaning.

- (7) Max ran at 3pm

(7) is true only if Max *starts* to run *at* 3pm. For Dowty, the point of time at which Max starts to run must be equated with the *initial bound* of the interval at which "Max runs", i.e. [DO(max',running-state'(max'))], is true. So to capture the inchoative reading of (7) in the truth conditions of (7a), one must have the following truth conditions for [AT(3pm,Φ)] (so R is the *initial bound* relation):

New Conditions for [AT(3pm,Φ)]

[AT(3pm,Φ)] is true at the interval I if and only if 3pm is the initial bound of I and Φ is true at I.

One now has the problem of squaring this definition of [AT(3pm,Φ)] with the representation of sentence (8). The representation of sentence (8) is (8a).

- (8) Max won the race at 3pm
- (8a) [PAST + [AT(3pm, [BECOME winner'(max',race'))]]]

Consider the following situation: suppose Max begins to win the race at 3pm, and crosses the finish line in first place at 5pm. Then according to Dowty's definition of BECOME, the formula (22) is true at the interval spanning 3pm to 5pm (which is denoted by the open interval (3pm,5pm)).

- (22) [BECOME winner'(max',race')]

So according to the new definition for [AT(3pm,Φ)], sentence (23) is true at the interval (3pm, 5pm).

(23) [AT(3pm, [BECOME winner'(max',race')])]

Therefore sentence (8a) is true at an interval later than (3pm, 5pm).

This interpretation of (8) does *not* respect its actual use. The only natural interpretation of (8) is one in which Max is the winner of the race at 3pm. (8) should therefore be *false* with respect to the situation described, since Max is not the winner of the race until 5pm. If the definition of [AT(3pm,Φ)] accounts for the natural interpretation of sentence (7), then it is in direct conflict with Dowty's definition for BECOME. Therefore if one is to represent the natural interpretation of (8), one is forced either to change the interpretation of achievement sentences, or change the definition of [AT(3pm,Φ)].

Suppose now that one attempts to define [AT(3pm,Φ)] so that (8a) captures the meaning of (8). 3pm must be identified as the time when Max crosses the finish line in first place, which occurs at the *final bound* of the interval I at which [BECOME winner'(max',race')] is true. So in order for (8a) to adequately represent (8), [AT(3pm,Φ)] receives the following definition (so R is the *final bound* relation):

[AT(t,Φ)] is true at the interval I if and only if t is the final bound of I and Φ is true at I.

One now has the problem of squaring this definition of AT with the representation of (7).

Consider the following situation: suppose that Max starts to run at 2pm and finishes running at 3pm. Then (19) is true at the interval (2pm,3pm).

(19a) [AT(3pm, [DO(max',running-state'(max'))])]

Hence sentence (7a), the representation of (7), is true with respect to this situation (provided the utterance time is after (2pm,3pm)).

(7a) [PAST + [AT(3pm, [DO(max',running-state'(max'))])]]

This does not respect the natural, inchoative interpretation of (7), since Max *finishes* running at 3pm, rather than starts to run. If the definition of [AT(3pm,Φ)] captures the natural interpretation of (8), then it is in direct conflict with Dowty's interpretation of activities.

A representation of "At 3pm" that captures the natural, inchoative interpretation of (7) is in direct conflict with Dowty's interpretation of achievement sentences. Furthermore, the

representation of "At 3pm" that captures the natural interpretation of (8) is in direct conflict with Dowty's interpretation of activity sentences. The problem can be seen as one of squaring the initial bound relation required of R to represent (7), in contrast with the final bound relation required of R to represent (8).

At this point, there are three strategies one could adopt to resolve the situation. The first of these is to have two separate definitions for "At 3pm", one for activities, and the other for achievements. The shortcomings of this strategy are obvious; one should have a uniform definition for "At 3pm".

The second strategy is to fix the definition of "At 3pm" so that (8a) captures the meaning of (8) (so R is the final bound relation), and revise the interpretation of activities so that this definition may also predict the inchoative interpretation with activities. The third strategy is to fix the definition of "At 3pm" so that (7a) captures the meaning of (7) (so R is the initial bound relation), and revise the interpretation of achievements so that this definition of "At 3pm" may also capture the natural interpretation with achievements. Whether we follow the second or third strategy, we are forced to change Dowty's interpretation of the aspectual classes. The question now is: what changes are necessary?

5.4 A Change to Dowty's Interpretation of the Aspectual Classes

5.4.1 A Change to Activities

I will now examine the second strategy; i.e. I will investigate how one might revise the interpretation of activities so that the representation of "At 3pm" below, that captures the meaning of (8), also captures the (inchoative) meaning of (7):

[AT(3pm,Φ)] is true at the interval I if and only if 3pm is the final bound of I and Φ is true at I.

To capture the inchoative interpretation of (7) with the above definition for AT, activities must be true *only at minimal intervals* (i.e. moments).

(7) Max ran at 3pm

For suppose that there is a non-minimal interval I at which "Max runs" is true. Suppose that the initial bound of I is 3pm and the final bound is t (3pm ≠ t). Then the above definition for AT

predicts that (7) is false at I. But 3pm is the time that Max *starts* to run, and so according to intuitions (7) is true at I. Therefore, activity sentences cannot be true at non-minimal intervals: they must be true only at minimal intervals.

Now suppose that activities are true only at minimal intervals, and suppose that we interpret activities so that if "Max runs" is true at {3pm}, then Max *starts* to run at 3pm. 3pm is the final bound of {3pm}, and so if "Max runs" is true at {3pm}, (7) is true. Hence (7) has an inchoative reading, as required, for the truth conditions of (7) identify 3pm with the time that Max starts to run. However, the assumption that activity sentences are false at all *non-minimal* intervals is clearly unviable, since our intuitions tell us that activities can happen over a period of time. Hence fixing the representation of "At 3pm" to capture the meaning of (8) and changing the interpretation of activity sentences, although a technically viable strategy, is materially inadequate.

5.4.2 A Change to Achievements

One is now left with only the third strategy to explain the natural meanings of (7) and (8), and that is to revise the interpretation of *achievement* sentences so that the representation of "At 3pm" below, that captures the inchoative meaning of (7), also captures the natural meaning of (8).

[AT(3pm,Φ)] is true at I if and only if 3pm is the initial bound of I and Φ is true at I.

This definition of AT will capture the natural interpretation of (8) only if achievement sentences are *false* at all non-minimal intervals.

(8) Max won the race at 3pm

For suppose that there is a non-minimal interval I at which "Max wins the race" is true. Suppose the initial bound of I is t and the final bound is 3pm (so Max crosses the finish line in first place at 3pm and $t \neq 3pm$). Then the above definition for AT predicts that (8) is false. But 3pm is the time Max crosses the finish line in first place, and so according to intuitions (8) is true. Therefore, achievement sentences such as "Max wins the race" cannot be true at non-minimal intervals; they must be true *only at minimal intervals* (i.e. moments).

If achievement sentences are true *only at minimal* intervals and *never* true at *non-minimal* intervals, then the above definition of [AT(3pm,Φ)] allows for a satisfactory representation of the meaning of (8). For (i) the interval {t} at which "Max wins the race" is true must be the time at which Max crosses the finish line, and (ii) since "Max wins the race" is true only at minimal

intervals (i.e. moments), (8) is true only if "Max wins the race" is true at {3pm}. So the new interpretation of (8) identifies 3pm as the time when Max crosses the finish line in first place, as required. Therefore, in order to represent adequately (7) and (8), one must assume that achievement sentences are true *only at moments*.

What are the consequences of the revised interpretation of achievement sentences? First, the operator BECOME can no longer feature in the logical form for achievements. But as we will see in the next chapter, Dowty's operator BECOME plays a key role in his solution to the imperfective paradox.

Furthermore, we have undermined the very foundations of Dowty's *Heterogeneous Strategy* for distinguishing the semantics of linguistic expressions of different aspectual classes. The converse principle to heterogeneity is *homogeneity*: A sentence is homogeneous if its truth at an interval I entails its truth at all subintervals of I. The new interpretation of achievements undermines the Heterogeneous Strategy because the assumption that achievement sentences are true only at minimal intervals and the assumption that they are *homogeneous* are equivalent. This is shown as follows: if achievement sentences are true only at minimal intervals, then this does not allow for the possibility that an achievement sentence A is true at an interval I and false at an interval J which is contained in I (for I has no subintervals). So achievement sentences are homogeneous. On the other hand, a homogeneous interpretation of achievement sentences is satisfactory only if they are true only at minimal intervals. To see this, suppose that an achievement sentence A is true at a *non-minimal* interval I in a homogeneous environment. Then A must be true at every interval J contained in I. One is now committed to one of two undesirable consequences. The first alternative is that the structural representation of A is not related to the 'culmination' of the achievement. The second alternative is that A has a culmination associated with it, but homogeneity entails that this culmination occurs at every interval contained in I (since A is true at every interval contained in I). Hence a homogeneous interpretation of achievement sentences is satisfactory only if they are true only at minimal intervals. Hence the homogeneous analysis of achievement sentences is equivalent to the analysis where they are true only at minimal intervals¹⁸.

So to conclude, we have explored all the possible ways in which Dowty might represent sentences (7) and (8).

(7) Max ran at 3pm

¹⁸ By a similar argument, *accomplishments* are homogeneous if and only if they are true only at minimal intervals.

(8) Max won the race at 3pm

First, there was a choice in logical form; (8) could have logical form (8a) or (8b).

(8a) [PAST + [AT(3pm,[BECOME winner'(max',race')]])]

(8b) [PAST + [BECOME [AT(3pm,winner'(max',race')]])]

We argued that either way, Dowty's eternal nature of AT is not sustainable. Furthermore, even if one relaxes the condition that AT is an eternal sentence, one still cannot rescue (8b) as the representation of (8). Therefore we concluded that the logical form of (8) must be (8a).

This logical form for (8) lead to a tension between the definition of AT required to capture the natural interpretation of (8), and the definition of AT required to capture the natural interpretation of (7). We were forced by this tension to change Dowty's interpretation of the aspectual classes. We demonstrated that although changing Dowty's interpretation of activity sentences was a technically viable strategy, it was materially inadequate. We were therefore forced to change Dowty's interpretation of achievement sentences. We then showed that the only way one can represent sentences (7) and (8) in Dowty's framework is to assume that achievement sentences are true only at *minimal intervals*. This is equivalent to a *homogeneous* interpretation of achievements. Therefore, in order to represent (7) and (8), one must assume that achievement sentences are homogeneous.

We have seen that heterogeneity may not be sustainable, for achievements at least. The puzzle now is: can homogeneity yield a satisfactory semantic distinction between activity sentences such as "Max ran" and achievement sentences such as "Max won the race"? This puzzle is answered in chapter 6.

We have now examined Dowty's formulation of the Heterogeneous Strategy in an interval-based framework. It fails, because heterogeneity is not sustainable in Dowty's theory, for achievements at least. But can Taylor's (1977, 1985) formulation of the Heterogeneous Strategy do any better than Dowty's? Let us first examine the role of heterogeneity in Taylor's theory, and then see if his formulation is subject to the same puzzles as Dowty's.

6 Taylor's Semantic Interpretation of the Aspectual Classes

Taylor aims to augment the Davidsonian analysis of adverb modification with a *theory of events*, and an essential part of this theory is his heterogeneous interpretation of the aspectual classes.

Davidson's proposal is that putative n -place predicates capable of adverbial modification should be regarded as $(n+1)$ -place predicates, with the extra argument place reserved for a singular term designating an event. Adverbs should be taken as expressing properties of the events thus invoked. A *theory of events* must explain how events relate to each other, whilst refusing to countenance such negative events as Brutus' not stabbing Caesar. Taylor's objective is to provide such a theory of events.

It must be stressed that the aims of Taylor's theory are different to Dowty's. Taylor does not address the problem of the imperfective paradox. Unlike Dowty, he does *not* offer a definition of the progressive that solves the imperfective paradox. However, he fulfils the task connected with the imperfective paradox that is under examination in this chapter: he provides a semantic distinction between expressions of different aspectual classes. Taylor uses this to distinguish events from facts.

The role heterogeneity plays in Taylor's theory is revealed in his semantic interpretation of Aristotle's classification of verbs. This classification is a trichotomy, the distinguishing classes being S("state")-verbs, E("energia")-verbs and K("kinesis")-verbs. S-verbs correspond to Vendler's stative verbs, E-verbs correspond to Vendler's activities, and K-verbs to Vendler's accomplishments and achievements, grouped together in one class. Let us examine the backdrop of Taylor's theory, as a preliminary to reviewing his heterogeneous interpretation of Aristotle's trichotomy.

6.1 Taylor's Analysis of Tense and Atomic Form

Taylor's base formalism, which is called LE, contains variables that range over *times*, and also includes constants representing the natural language terms "now" and "then". Taylor distinguishes two kinds of times; indivisible *moments* and longer temporal *periods*. The distinction between moments and periods is marked with the aid of predicates; Mom(t) ("t is a moment") and Per(t) ("t is a period"). The relations expressible between times are then represented as follows:

" $t < t'$ " means "t is earlier than t'".

" $t \subset t'$ " means "t falls properly within t'".

" $t \subseteq t'$ " means "t falls within t'", i.e. t either is t', or else t falls properly within t'.

Taylor also offers an axiomatic theory of time from which it follows that time is dense and continuous. The related notions such as "subinterval" and "initial bound" are defined so as to correspond to intuitions.

Taylor analyses predicates in the base formalism as relativised to times. The reading of sentence (24) is "t is a time of Max's being taller than John".

(24) Taller(max, john, t)

If (24) is true, then one can say that t is a *time of application* of the predicate "Taller".

The representation of the *simple present* tensed sentence (25) is formula (25a).

(25) Max is taller than John

(25a) Taller(max, john, now)

The representations of the *simple past* sentence (26) and the *simple future* sentence (27) are (26a) and (27a) respectively.

(26) Max was taller than John

(26a) $(\exists t)(t < \text{now} \ \& \ \text{Taller}(\text{max}, \text{john}, t))$

(27) Max will be taller than John

(27a) $(\exists t)(\text{now} < t \ \& \ \text{Taller}(\text{max}, \text{john}, t))$

(26a) paraphrases as "there is a time t *earlier* than now such that t is a time of Max's being taller than John". (27a) paraphrases as "there is a time t *later* than now such that t is a time of Max's being taller than John".

6.2 The Postulates

We are now in a position to discuss Taylor's semantic characterisation Aristotle's classification of verbs.

Taylor observes that a *state*, such as Rod's being hirsute, need not take an interval of time. In contrast, he claims that an E-expression, such as Rod's chuckling, or a K-expression, such as Rod's pulling a pint, necessarily take time.

To reflect these intuitions in the formalism LE, he defines a postulate for states, which stipulates that if t is a period of application of an S-verb, then every moment m in t is also a time of application of the S-verb. In contrast, if t is a time of application of an E-verb or K-verb, then t must be a period.

Taylor defines the postulates with the following symbolism: S, K and E-verbs will be represented in the base language by use of a predicate constant in the corresponding category. (This will be defined as the theory is developed). Let P_j^n be the j -th n -place predicate constant of the base formalism, and let V_j^n be the result of filling its first $n-1$ argument places by distinct variables (say, the first $n-1$ variables in some specified standard ordering). Where there is no confusion, I shall abbreviate P_j^n and V_j^n to P^n and V^n respectively. Postulates 1 and 2 are as follows:

Postulate 1 (for S-verbs)

P^n should count as an S-predicate if it meets the following condition:

$$\text{Per}(t) \rightarrow (V^n(t) \equiv (\forall t')((\text{Mom}(t') \ \& \ t' \subset t) \rightarrow V^n(t')))$$

Postulate 2 (for E and K-verbs)

If P^n is an E or K-predicate, then it should meet the following condition:

$$V^n(t) \rightarrow \text{Per}(t)$$

For example, the verb phrase "is taller than" is stative, so by postulate 1 the predicate "Taller" satisfies condition (28) for all times t : in other words, if max is taller than john over t , then max is taller than john over every moment t' contained in t .

$$(28) \quad \text{Per}(t) \rightarrow (\text{Taller}(\text{max}, \text{john}, t) \Leftrightarrow (\forall t')((\text{Mom}(t') \ \& \ t' \subset t) \rightarrow \text{Taller}(\text{max}, \text{john}, t')))$$

The verb "run" is an E-verb, and so by postulate 2 the E-predicate "Run" satisfies condition (29) for all t : in other words, if max runs over time t , then t must be a period.

$$(29) \quad \text{Run}(\text{max}, t) \rightarrow \text{Per}(t)$$

Postulate 2 expresses a feature common to both E and K-verbs. This postulate forms the foundation for postulate 3 on E-verbs, which stipulates that if t is a time of application of an E-verb then all periods contained in t are times of application of the E-verb: This reflects the idea that every part of a process is itself a process. Furthermore, postulate 3 adds a condition that the time t of application of the E-verb must be contained in an open interval that is also a time of application of the E-verb: this reflects the idea that processes don't have definite endpoints. Postulate 3 is given below ("OF(t')" means " t' is an open interval"):

Postulate 3 (for E-verbs)

$$V_j^n t \rightarrow \text{Per}(t) \ \& \ (\exists t')(\text{OF}(t') \ \& \ t \sqsubset t' \ \& \ V_j^n t') \\ \& \ (\forall t'')(t'' \sqsubset t \ \& \ \text{Per}(t'') \rightarrow V_j^n t'')$$

Postulate 2 also forms the foundations for postulate 4 for K-verbs, which stipulates that if t is the time of application of a K-verb, then there is no time contained in t which is also the time of application of the K-verb; this reflects the idea that, in Vendler's terms, no part of an accomplishment is itself an accomplishment.

Postulate 4 (for K-verbs)

$$V_j^n t \rightarrow \text{Per}(t) \ \& \ (\forall t')(t' \sqsubset t \rightarrow \neg V_j^n t')$$

Taylor adds minor revisions to postulates 3 and 4 on the grounds of a spatial analogy. The revised descriptions of E and K-verbs, however, still rest on postulate 2. The revisions are irrelevant to the purposes of this chapter, for they do not affect the nature of heterogeneity in Taylor's theory. They are given in appendix 3.

Postulates 2, 3 and 4 entail that t may be a time of application of an E or K-predicate, even though t' is not a time of application of the E or K-predicate, where t' is contained in t (for E-predicates, this follows only if t' is a moment). Hence these postulates describe the semantics of E and K-verbs using a *heterogeneous* interval structure; so Taylor is adopting the *Heterogeneous Strategy* for interpreting the aspectual classes.

Dowty's and Taylor's theories are superficially very different, for they are stated in different frameworks. Taylors' theory is *not* interval-based, for the framework is Davidsonian and so the truth values of sentences are not given relative to intervals of time. A sentence in Taylor's theory is true or false simpliciter. Nevertheless, the role of heterogeneity resulting from postulates 2, 3 and 4 in Taylor's theory bears striking similarities to the role of heterogeneity in Dowty's theory. For Taylor, the only times of application of E-verbs (i.e. activities) and K-verbs (achievements) are non-minimal. Similarly for Dowty, activities and achievements are true only at non-minimal intervals. Moreover, postulate 4 entails that t may be a time of application of an achievement, even though the interval t' which is contained in t is not a time of application of the achievement. Similarly in Dowty's theory, an achievement may be true at an interval t and false at an period t' contained in t ¹⁹.

¹⁹ One might think it possible to translate Taylor's theory into Dowty's interval-based framework. However, Taylor treats predicates from all aspectual classes as primitive and for Dowty, only the stative predicates are primitive.

7 Taylor's Representation of Point Adverbials

Dowty's heterogeneous interpretation of the aspectual classes could not yield a satisfactory definition of the point adverbial "At 3pm", as it appears in sentences (7) and (8).

- (7) Max ran at 3pm
- (8) Max won the race at 3pm

Can Taylor's heterogeneous interpretation of the aspectual classes do any better?

7.1 Events and Adverbs

In order to clarify Taylor's representations of (7) and (8), one must understand his theory of events, and his Davidsonian interpretation of adverbial modification. (In what follows, no commitment to Taylor's theory of events is intended).

Taylor uses Aristotle's trichotomy to produce a theory of events. He argues that events should be viewed as a species of states of affairs, and uses the analysis of Aristotle's classification of verbs to determine which states of affairs are events. He stipulates the following conditions on eventhood:

- (1) Events are one and all *facts* (i.e. obtaining states of affairs).
- (2) Events must be *temporally continuous changes*: Max's being noble is not an event, in contrast with his running or winning the race. Moreover, Reagan's eating breakfast and eating dinner each describe an event, but there is no one event of his eating both.
- (3) An Event must be continuously manifested *in some one object*. Jack's climbing Everest and Jill's climbing Ben Nevis are both events, but they do not constitute a single event.

Taylor claims that according to his analysis of Aristotle's trichotomy, in particular the contrast between postulates 1 and 2, the verbs that record 'changes' are exactly the E and K-predicates, for it is these predicates that *take time*. Hence Aristotle's partition of verbs is one of the factors that separates events from facts.

In order to respect Davidson's representation of adverb modification in the *object language*, Taylor forms an extension LE+ of the existing object language LE, where LE+ is augmented with an apparatus sufficient for it to discuss its own states of affairs and events. Taylor adds to LE the operator "ST" (read as "the state of affairs that"), so that:

If A is a well formed formula of LE, then ST[A] is a term of LE+.

The term $ST[A]$ should be glossed as "the state of affairs that A". The denotation of these terms in the metalanguage are states of affairs. $LE+$ also has variables "X", "Y", "Z",... ranging over states of affairs. These are called *state variables*. State terms are the *second level terms* of $LE+$. The first level terms of $LE+$ are the terms of LE unaugmented.

$LE+$ also has a range of *second level predicates*. These predicates come in various types $\langle i_1, \dots, i_n \rangle$, where each $i_j = 1$ or 2 . If $i_j = 1$, then a first level term is required in its place, and if $i_j = 2$, then a second level term is required in its place. For example, if the predicate "P" is of type $\langle 1, 2 \rangle$, then it is a two-place predicate, whose first argument ranges over first level terms, and whose second argument ranges over second level terms.

$LE+$ contains a second level identity predicate "=" of type $\langle 2, 2 \rangle$, and a predicate "Ob" of type $\langle 2 \rangle$ (read as "obtains"), a predicate "Ev" of type $\langle 2 \rangle$ (read as "is an event", and is subject to the constraints on eventhood that we have stipulated), and a predicate "Cons" of type $\langle 2, 2 \rangle$ (read "is a constituent of", and corresponding in the metalanguage to the containment of one state of affairs in a more complex one).

Having introduced these second level predicates, Taylor defines when a state of affairs X is a stabbing, when X occurs over t, when the agent of X is the individual x, when the object of X is x, and so on. These definitions play an essential role in the final representation of natural language sentences.

Intuitively, the state of affairs X is a stabbing only if for each of its constituent states of affairs Y, Y is $ST[Stab(x, y, t)]$ for some individuals x and y and some time t. Taylor captures this intuition in the following definition:

[DEF 1'] X is a STABBING \Leftrightarrow
 $Ev(X) \ \& \ (\forall Y)(Cons(Y, X) \rightarrow$
 $(\exists x)(\exists y)(\exists t)(Y = ST[Stab(x, y, t)]))$

Intuitively, the state of affairs X occurs over t if for every constituent state of affairs Y of X, Y is a state of affairs where t is a time of application of the predicate. Taylor captures these intuitions by defining when the state of affairs X *occupies* t ("X occurs over t") as follows:

[DEF 2'] X OCCUPIES t \Leftrightarrow
 $Ev(X) \ \& \ (\exists \Phi^n)(\forall Y)(Cons(Y, X) \rightarrow$
 $(\exists x_1) \dots (\exists x_{n-1})(Y$
 $= ST[\Phi^n(x_1, \dots, x_{n-1}, t)]))$

Taylor views the agent of a state of affairs X as the individual x if one of the constituent states of affairs of X is $ST[P(x, x_2, \dots, x_n, t)]$, for some predicate P , some individuals x_2, \dots, x_n , and some time t . Taylor formulates this in the definition below:

$$[DEF 3'] \quad X \text{ is BY } x \iff \begin{aligned} &Ev(X) \ \& \ (\exists Y)(Cons(Y, X) \ \& \\ &(\exists \Phi^n)(\exists x_1) \dots (\exists x_{n-1})(\exists t)(Y = \\ &ST[\Phi^n(x_1, \dots, x_{n-1}, t)] \ \& \ x_1 = x)) \end{aligned}$$

Taylor's definition of the conditions under which an individual x is the *object* of a state of affairs X is similar to that for the *agent*. The state of affairs X is OF x (i.e. "the individual x is the object of X ") if there is a constituent state of affairs of X that is $ST[P(x_1, x, x_3, \dots, x_n, t)]$, for some predicate P , some individuals x_1, x_3, \dots, x_n and some time t . This is captured in the definition below:

$$[DEF 4'] \quad X \text{ is OF } x \iff \begin{aligned} &Ev(X) \ \& \ (\exists Y)(Cons(Y, X) \ \& \\ &(\exists \Phi^n)(\exists x_1) \dots (\exists x_{n-1})(\exists t)(Y = \\ &ST[\Phi^n(x_1, \dots, x_{n-1}, t)] \ \& \ x_2 = x)) \end{aligned}$$

LE+ has *axioms* which reflect the following ideas:

- (i) If X is an event then X obtains (i.e. X is a fact).
- (ii) X obtains if and only if every constituent member of X obtains
- (iii) The state of affairs $ST[P^n(x_1, \dots, x_n)]$ obtains if and only if $P^n(x_1, \dots, x_n)$ is true.

These axioms are given below:

$$\begin{aligned} [AX 1] \quad &Ev(X) \rightarrow Ob(X) \\ [AX 2] \quad &(\exists Y)(Cons(Y, X) \rightarrow (Ob(X) \iff \\ &(\forall Z)(Cons(Z, X) \rightarrow Ob(Z))) \\ [AX OB 1] \quad &Ob(ST[P^n x_1 \dots x_n]) \iff P^n x_1 \dots x_n \end{aligned}$$

7.2 The Logical Form of Point Adverbials

Now that the representation language is in place, I will discuss the representations of sentences (7) and (8).

- (7) Max ran at 3pm
- (8) Max won the race at 3pm

The point adverbial "At 3pm" is represented in LE+ by the second level predicate "AT" of type <1,2>: the first argument is the moment 3pm, and the second argument is a state variable. The logical forms of (7) and (8) are (7a') and (8a') respectively.

- (7a') $(\exists t)(\exists X)(t < \text{now} \ \& \ \text{Ev}(X) \ \& \ X \text{ is a RUNNING} \ \& \ X \text{ is BY max uniquely} \ \& \ X \text{ OCCUPIES } t \ \& \ \text{AT}(3\text{pm}, X))$
(8a') $(\exists t)(\exists X)(t < \text{now} \ \& \ \text{Ev}(X) \ \& \ X \text{ is a WINNING} \ \& \ X \text{ is BY max uniquely} \ \& \ X \text{ is OF race uniquely} \ \& \ X \text{ OCCUPIES } t \ \& \ \text{AT}(3\text{pm}, X))$

(7a') can be paraphrased as: there is a time t and state of affairs X such that t is earlier than the utterance time, X is an event, X is a running, the unique agent of X is Max, X occurs over t and X is AT 3pm. The paraphrase of (8a') is similar.

In order to evaluate how (7a') and (8a') might represent the natural interpretations of (7) and (8), we must answer the following question: how do we translate the formula $\text{AT}(3\text{pm}, X)$? To answer this question, I will investigate what already logically follows from (7a'), given Taylor's definitions for "X is a RUNNING", "X OCCUPIES t " etc.

According to [DEF 1'] and [DEF 3'], sentence (7b) is valid (the RHS of the equivalence is given simply by the definitions of "X is a RUNNING" and "X is BY max uniquely").

- (7b) $X \text{ is a RUNNING} \ \& \ X \text{ is BY max uniquely} \iff \text{Ev}(X) \ \& \$
(i) $(\forall Y)(\text{Cons}(Y, X) \rightarrow (\exists x)(\exists t)(Y = \text{ST}[\text{Run}(x, t)])) \ \& \$
(ii) $(\exists Y)(\text{Cons}(Y, X) \ \& \ (\exists \Phi^n)(\exists x_2) \dots (\exists x_{n-1})(\exists t)(Y = \text{ST}[\Phi^n(\text{max}, \dots, x_{n-1}, t)]) \ \& \ (\forall y)(X \text{ is BY } y \rightarrow y = \text{max}))$

By expression (ii) in the above formula, the only substitution instance for "x" in expression (i) that can satisfy (7b) is "max". Moreover, because of expression (i) in (7b), the only substitution instance of the predicate " Φ^n " in expression (ii) that will satisfy (7b) is the predicate "Run". Hence (7b) is true if and only if (7c) is true.

- (7c) $X \text{ is a RUNNING} \ \& \ X \text{ is BY max uniquely} \iff \text{Ev}(X) \ \& \$
(i) $(\forall Y)(\text{Cons}(Y, X) \rightarrow (\exists t)(Y = \text{ST}[\text{Run}(\text{max}, t)])) \ \& \$
(ii) $(\exists Y)(\text{Cons}(Y, X) \ \& \ (\exists t)(Y = \text{ST}[\text{Run}(\text{max}, t)]))$

Now (7c) is equivalent to (7d) (we have added to the LHS the formula "X OCCUPIES t " and to the RHS, we have added the technical definition of "X OCCUPIES t " given in [DEF 2']).

- (7d) $X \text{ is a RUNNING} \ \& \ X \text{ is BY max uniquely} \ \& \ X \text{ OCCUPIES } t \iff \text{Ev}(X) \ \& \$

- (i) $(\forall Y)(\text{Cons}(Y,X) \rightarrow (\exists t')(Y = \text{ST}[\text{Run}(\text{max},t')]) \&$
- (ii) $(\exists Y)(\text{Cons}(Y,X) \& (\exists t')(Y = \text{ST}[\text{Run}(\text{max},t')]) \&$
- (iii) $(\exists \Phi^n)(\forall Y)(\text{Cons}(Y,X) \rightarrow (\exists x_1) \dots (\exists x_{n-1})(Y = \text{ST}[\Phi^n(x_1, \dots, x_{n-1}, t)])$

By expression (iii) in the above formula, the only possible substitution instance of "t'" in expressions (i) and (ii) is "t". Hence the truth of (7d) is equivalent to the truth of (7e).

- (7e) $X \text{ is a RUNNING} \& X \text{ is BY max uniquely} \& X \text{ OCCUPIES } t \Leftrightarrow \text{Ev}(X) \& (\forall Y)(\text{Cons}(Y,X) \rightarrow Y = [\text{ST}(\text{Run}(\text{max},t))]) \& (\exists Y)(\text{Cons}(Y,X) \& Y = \text{ST}[\text{Run}(\text{max},t)])$

(7e) is equivalent to (7f), since the only possible substitution instance for X is $\{\text{ST}[\text{Run}(\text{max},t)]\}$, which is coreferring with $\text{ST}[\text{Run}(\text{max},t)]$ (by Taylor's characterisation of states of affairs in the metalanguage (Taylor 1985: 86)).

- (7f) $X \text{ is a RUNNING} \& X \text{ is BY max uniquely} \& X \text{ OCCUPIES } t \Leftrightarrow X = \text{ST}[\text{Run}(\text{max},t)] \& \text{Ev}(\text{ST}[\text{Run}(\text{max},t)])$

By [AX 1], (7f) is equivalent to (7g).

- (7g) $X \text{ is a RUNNING} \& X \text{ is BY max uniquely} \& X \text{ OCCUPIES } t \Leftrightarrow \text{Ev}(X) \& X = \text{ST}[\text{Run}(\text{max},t)] \& \text{Ob}[\text{ST}(\text{Run}(\text{max},t))]$

By [AX OB 1], (7g) is equivalent to (7h).

- (7h) $X \text{ is a RUNNING} \& X \text{ is BY max uniquely} \& X \text{ OCCUPIES } t \Leftrightarrow \text{Ev}(X) \& X = \text{ST}[\text{Run}(\text{max},t)] \& \text{Run}(\text{max},t)$

Hence sentence (7a'), which is the representation of (7), is equivalent to (7i).

- (7) Max ran at 3pm
- (7a) $(\exists t)(\exists X)(t < \text{now} \& X \text{ is a RUNNING} \& X \text{ is BY max uniquely} \& X \text{ OCCUPIES } t \& \text{AT}(3\text{pm}, X))$
- (7i) $(\exists t)(t < \text{now} \& \text{Ev}(\text{ST}[\text{Run}(\text{max},t)]) \& \text{Run}(\text{max},t) \& \text{AT}(3\text{pm}, \text{ST}[\text{Run}(\text{max},t)]))$

Now the state of affairs $\text{ST}[\text{Run}(\text{max},t)]$ satisfies conditions (2) and (3) for eventhood that were described above: for (2) Taylor claims it denotes a continuous temporal change since "Run" is an E-verb, and (3) it manifests itself in one object, namely Max. So for the state of affairs $\text{ST}[\text{Run}(\text{max},t)]$ to be an event, there is only one remaining condition that must be satisfied, and that is that $\text{ST}[\text{Run}(\text{max},t)]$ must obtain. By [AX OB 1], $\text{ST}[\text{Run}(\text{max},t)]$ obtains if and only if

Run(max,t) is true. So the truth of $\text{Ev}(\text{ST}[\text{Run}(\text{max},t)])$ is equivalent to the truth of Run(max,t). Therefore (7i) is equivalent to (7j), and so (7j) can be regarded as a canonical representation of (7).

$$(7j) \quad (\exists t)(t < \text{now} \ \& \ \text{Run}(\text{max},t) \ \& \ \text{AT}(3\text{pm},\text{ST}[\text{Run}(\text{max},t)]))$$

How is one to translate the formula $\text{AT}(3\text{pm},\text{ST}[\text{Run}(\text{max},t)])$ so that it squares with the natural, inchoative interpretation of sentence (7)? (7j) is true only if $\text{AT}(3\text{pm},\text{ST}[\text{Run}(\text{max},t)])$ and Run(max,t) are both true for some time t. So the translation of $\text{AT}(3\text{pm},\text{ST}[\text{Run}(\text{max},t)])$ might specify a relationship R' between 3pm and t, such that Run(max,t) is true. i.e. the translation of $\text{AT}(3\text{pm},\text{ST}[V^n(t)])$ follows the schema given below (where V^n is the 1-place predicate that results from filling the first n-1 arguments of the n-place predicate P^n).

$$\text{AT}(3\text{pm},\text{ST}[V^n(t)]) \iff 3\text{pm}R't \ \& \ V^n(t)$$

By postulate 2, (30) is valid.

$$(30) \quad \text{Run}(\text{max},t) \rightarrow \text{Per}(t)$$

So the substitution instances for the variable "t" that satisfy formula (7j) are all periods. Hence we are left with the question: What relationship R' between the *moment* 3pm and the *period* t in the translation of $\text{AT}(3\text{pm},\text{ST}[\text{Run}(\text{max},t)])$ captures the natural meaning of sentence (7)?

The final semantic representations of (7) and (8) in Dowty's theory and in Taylor's appear very different. For Dowty, "At 3pm" is represented as a sentential operator and for Taylor, it is a predicate of events. But in spite of this difference, we have come up against a task in Taylor's theory that is analogous to the task we encountered in Dowty's. In Dowty's theory, we found that in order to represent (7), we had to specify a relation R between 3pm and the interval I at which "Max runs" is true. In Taylor's theory, we have to specify a relation R' between 3pm and the interval t such that Run(max,t) is true. The question now is: how should R' be specified?

7.3 The Relation R' in the Translation of $\text{AT}(3\text{pm},\text{ST}[V^n(t)])$

How is one to express the relationship R' between 3pm and t in the translation of $\text{AT}(3\text{pm},\text{ST}[V^n(t)])$? Let us first examine the constraints required on R' for (7a') to capture (7)'s natural, inchoative interpretation.

(7) Max ran at 3pm

(7a') is true if and only if (7j) is true, if and only if (31) holds for some time t earlier than the utterance time.

(31) $AT(3pm, ST[Run(max, t)]) \& Run(max, t)$

Max starts to run at the *initial bound* of the period t such that $Run(max, t)$ is true. So to capture the natural interpretation of (7), (31) must be true only if 3pm is the initial bound of the interval t . Therefore, following the above schema for translating AT, R' must express the *initial bound* relation between 3pm and t , so that the translation for $AT(3pm, ST[V^n(t)])$ is as follows:

Translation for $AT(3pm, ST[V^n(t)])$

If P^n is a first-level predicate of LE+, then

$AT(3pm, ST[V^n(t)]) \Leftrightarrow Initial_bound(3pm, t) \& V^n(t)$ ²⁰

One now has the problem of squaring this definition of "At 3pm" with the natural interpretation of sentence (8). The representation of sentence (8) is (8a'), which in turn is truth conditionally equivalent to (8j)²¹.

(8) Max won the race at 3pm

(8a') $(\exists t)((\exists X)(t < now \& X \text{ is a WINNING} \& X \text{ is BY max uniquely} \& X \text{ is OF race uniquely} \& X \text{ OCCUPIES } t \& AT(3pm, X))$

(8j) $(\exists t)(t < now \& Win(max, race, t) \& AT(3pm, ST[Win(max, race, t)]))$

Consider the following situation: suppose Max begins to win the race at 3pm, and crosses the finish line in first place at 5pm. Then by Taylor's postulates on K-verbs, (32) is true, where t is the time period spanning 3pm to 5pm.

(32) $Win(max, race, t)$

According to the translation of $AT(3pm, ST[V^n(t)])$, the formula (33) is true (since 3pm is the initial bound of t).

²⁰ The formula "Initial_bound(3pm, t)" is to be understood as "3pm is the initial bound of t ". The predicate "Initial_bound" is defined as follows:

$Initial_bound(t, t') \Leftrightarrow Mom(t) \& ((t \sqsubseteq t' \& (\forall t'')(t'' \sqsubset t' \rightarrow t \sqsubset t'')) \vee (\neg t \sqsubseteq t' \& t \sqsubset t' \& (\forall t'')(Mom(t'') \& t \sqsubset t'') \rightarrow (t'' \sqsubset t' \vee t' \sqsubset t''))))$

²¹ The deduction from (8a') to (8j) is similar to that between (7a') and (7j).

(33) $AT(3pm, ST[Win(max, race, t)])$

Therefore (34) is true.

(34) $AT(3pm, ST[Win(max, race, t)]) \& Win(max, race, t)$

Therefore, assuming that t is earlier than the utterance time, (8j), which is equivalent to the representation of (8), is true.

This interpretation of (8) does *not* respect its actual use. The only natural interpretation of (8) is one in which Max crosses the finish line in first place at 3pm. So we intuitively interpret (8) to be *false* with respect to the situation described, since Max does not cross the finish line until 5pm. Hence if the translation of "At 3pm" captures the natural interpretation of (7), then it is in direct conflict with Taylor's postulates for K-verbs.

Suppose now that one attempts to modify R' so that (8a') captures the meaning of (8). (8a') is true if and only if (34) holds for some time t earlier than the utterance time. By Taylor's postulates for K-verbs, Max crosses the finish line in first place at the *final bound* of t . So (8a') represents the natural interpretation of (8) if R' specifies the *final bound* relation between 3pm and t in the translation of $AT(3pm, ST[V^n(t)])$, i.e. $AT(3pm, ST[V^n(t)])$ is defined as follows:

$$AT(3pm, ST[V^n(t)]) \iff Final_bound(3pm, t) \& V^n(t) \quad ^{22}$$

One now has the problem of squaring this definition with the natural interpretation of (7).

Consider the following situation: suppose that Max starts to run at 2pm and finishes running at 3pm. Then $Run(max, t)$ is true, where t is the period of time spanning 2pm to 3pm. Therefore, since 3pm is the final bound of t , by the new translation of "AT", (35) is true.

(35) $AT(3pm, ST[Run(max, t)])$

Hence (31) is true.

(31) $AT(3pm, ST[Run(max, t)]) \& Run(max, t)$

So, assuming that t is earlier than the utterance time, (7j), which is equivalent to the representation

²² The predicate "Final_bound" is defined similarly to "Initial_bound"

of (7), is true. This does not respect the natural interpretation of (7), since Max *finishes* running at 3pm in this situation, rather than starts to run. If the translation of "At 3pm" captures the natural interpretation of (8), then it is in direct conflict with Taylor's postulates for E-verbs.

The representation of "At 3pm" that is required to interpret (7) is in direct conflict with Taylor's postulates for K-verbs. Furthermore, the representation of "At 3pm" that is required to interpret (8) is in direct conflict with Taylor's postulates for E-verbs. The problem can be seen as one of squaring the initial bound relation required of R' to represent (7), in contrast with the final bound relation required of R' to represent (8).

At this point, as we encountered with Dowty, there are three strategies one could adopt to resolve the situation. The first of these is to have two separate translations for "At 3pm", one for E-verbs and the other for K-verbs. The shortcomings of this strategy are obvious; one should have a uniform translation for "At 3pm".

The second strategy is to fix the definition of "At 3pm" so that (8a') captures the meaning of (8), (so R' is the final bound relation), and revise the interpretation of E-verbs so that this definition may also predict the natural, inchoative interpretation of (7). The third strategy is to fix the definition of "At 3pm" so that (7a') captures the inchoative interpretation of (7), (so R' is the initial bound relation), and revise the interpretation of K-verbs so that this definition also captures the natural interpretation of (8). Whether we follow the second or the third strategy, we are forced to change Taylor's interpretation of Aristotle's classification of verbs. The question now is: what changes are necessary?

7.4 A Change to the Interpretation of Aristotle's Trichotomy

7.4.1 A Change to E-verbs

I will now examine the second strategy; I will investigate how one might revise Taylor's postulates for E-verbs so that the translation of "At 3pm" repeated below, that captures the natural interpretation of (8), also captures the natural, inchoative interpretation of (7):

$$AT(3pm, ST[V^n(t)]) \iff Final_bound(3pm, t) \ \& \ V^n(t)$$

To capture the inchoative interpretation of (7) with the above definition for "At 3pm", the only times of application of E-verbs must be *moments*. For suppose that $Run(max, t)$ is true for some period t , and suppose that t is earlier than the utterance time. Suppose that the initial bound

of t is m and the final bound is $3pm$ ($m \neq 3pm$). So Max starts to run at m , and finishes running at $3pm$. $3pm$ is the final bound of t , and so the conditions on $AT(3pm, ST[Run(max, t)])$ are satisfied. Therefore (assuming that t is before utterance time), (7j), which is the representation of (7), is true.

(7) Max ran at 3pm

(7j) $(\exists t)(t < \text{now} \ \& \ AT(3pm, ST[Run(max, t)]) \ \& \ Run(max, t))$

But $3pm$ identifies the time when Max terminates running, rather than starts to run. We have failed to capture the inchoative meaning of (7). Therefore, the assumption that $Run(max, t)$ can be true for some period t is not sustainable. In other words, t must be a *moment* if $Run(max, t)$ is true.

If one revises Taylor's postulate for E-verbs so that the only times of application are moments, then the above representation of "At 3pm" captures the inchoative meaning of (7). This is shown as follows: Suppose we assume that whenever $Run(max, 3pm)$ is true, then Max *starts* to run at 3pm. The moment $3pm$ is the final bound of itself, and so if $Run(max, 3pm)$ is true, then so is $AT(3pm, ST[Run(max, 3pm)])$. Therefore (7) is true, where $3pm$ is the time that Max *starts* to run, as required. However, the assumption that the only times of application of E-verbs are moments is clearly unviable, since our intuitions tell us that processes can happen over a period of time. Hence fixing the representation of "At 3pm" to capture the meaning of (8) and changing the interpretation of E-verbs, although a technically viable strategy, is materially inadequate.

7.4.2 A Change to K-verbs

One is now left with only one strategy to represent (7) and (8), and that is to fix the representation of "At 3pm" to capture the inchoative interpretation of (7), and change the interpretation of *K-verbs* so that this representation also captures the meaning of (8). The definition of "At 3pm" that captures the inchoative interpretation of (7) is repeated below:

$$AT(3pm, ST[V^n(t)]) \iff \text{Initial_bound}(3pm, t) \ \& \ V^n(t)$$

This representation of "At 3pm" clashes with the assumption that K-verbs have *periods* as the times of application rather than moments. For suppose that $Win(max, race, t)$ is true for some *period* t . Suppose that the initial bound of t is $3pm$, and the final bound is m ($3pm \neq m$). So Max starts to win the race at $3pm$, and crosses the finish line at m . The formulae $\text{Initial_bound}(3pm, t)$ and $Win(max, race, t)$ are both true. Therefore, $AT(3pm, ST[Win(max, race, t)])$ is true. Suppose t is earlier than the utterance time. Then (8j), which is equivalent to the representation of (8), is true.

- (8) Max won the race at 3pm
 (8j) $(\exists t)(t < \text{now} \ \& \ \text{AT}(3\text{pm}, \text{ST}[\text{Win}(\text{max}, \text{race}, t)]) \ \& \ \text{Win}(\text{max}, \text{race}, t))$

But 3pm identifies the time that Max *starts* winning the race, rather than the time he actually wins it. So we have failed to capture the natural meaning of (8). Therefore, the assumption that $\text{Win}(\text{max}, \text{race}, t)$ can be true when t is a *period* is not sustainable. In other words, if $\text{Win}(\text{max}, \text{race}, t)$ is true, then t must be a *moment*.

Suppose that $\text{Win}(\text{max}, \text{race}, t)$ is true only if t is a moment. Then the above definition of "At 3pm" captures the natural meaning of (8). For (i) if $\text{Win}(\text{max}, \text{race}, 3\text{pm})$ is true then 3pm is the time at which Max crosses the finish line in first place, and (ii) the moment 3pm is the initial bound of itself, and so $\text{AT}(3\text{pm}, \text{ST}[\text{Win}(\text{max}, \text{race}, 3\text{pm})])$ is true if and only if $\text{Win}(\text{max}, \text{race}, 3\text{pm})$ is true. Therefore, (8j), the representation of (8), is true if and only if 3pm is earlier than the utterance time and 3pm is the time that Max crosses the finish line in first place, as required. Therefore, in order to give satisfactory representations of (7) and (8), one must assume that the *only* times of application of K-verbs are *moments*.

What are the consequences of the revised interpretation of K-verbs? First, the revised interpretation is in direct conflict with postulate 2. One must revise postulate 2 to postulate 2*.

Postulate 2*

If P^n is a K-predicate, then it must meet the following condition:

$$V^n(t) \rightarrow \text{Mom}(t)$$

Postulate 2 forms the foundations for Taylor's analysis of the aspectual classes. So in abandoning postulate 2, one is forced to make fundamental changes to this analysis.

Furthermore, we have undermined the role of heterogeneity in Taylor's theory. This is argued as follows: According to postulate 2*, if P^n is a K-predicate, then $V^n(t)$ entails that t is a moment (V^n is the result of filling P^n 's first $n-1$ arguments). So we cannot have the situation where $V^n(t)$ is true and $V^n(t')$ is false, where t' is contained in t (for there are no t' contained in t). Hence postulate 2* does not give a heterogeneous analysis of K-verbs. The new analysis of K-verbs is *homogeneous*: the truth of $V^n(t)$ entails the truth of $V^n(t')$ for all t' contained in t .

So to conclude, we have examined how Taylor might represent sentences (7) and (8).

- (7) Max ran at 3pm
 (8) Max won the race at 3pm

Given Taylor's interpretation of the aspectual classes, a tension arose in the representation of these sentences, between the translation of "At 3pm" required to interpret (7) and the translation of "At 3pm" required to interpret (8). We were therefore forced to modify Taylor's interpretation of the aspectual classes. We argued that the only way one may achieve an adequate representation of sentences (7) and (8) was to modify the interpretation of K-verbs, so that the only times of application of K-verbs are *moments*. This is equivalent to a *homogeneous* analysis. Therefore, in order to represent (7) and (8), one must assume that K-verbs are homogeneous.

We have now examined both Dowty's and Taylor's formulations of the *Heterogeneous Strategy* for distinguishing the semantics of expressions from different aspectual classes. Dowty's theory is stated in a (modal) interval-based framework, and Taylor's theory is stated in a (first order) event-based framework. So the two theories are very different on the surface. Nevertheless, in each case we come up with the same puzzle: the heterogeneous interpretation of K-verbs (or achievements in Dowty's terms) is not sustainable, if one is to supply satisfactory representations of sentences (7) and (8). The question now is: can *homogeneity* yield a satisfactory semantic interpretation of the aspectual classes?

8 Conclusion

Two tasks must be tackled in order to solve the imperfective paradox. The first is to characterise a semantic distinction between sentences like (4) and (6).

- (4) Max ran
- (6) Max won the race

The second is to provide a definition of the progressive that meshes with this semantic distinction and so results in a solution to the imperfective paradox. This chapter addressed the first of these tasks.

It was shown how some theories have attempted the task at hand by formalising Vendler's classification of aspect. These theories adopt what I have called the *Heterogeneous Strategy*: they invoke a heterogeneous interval structure in order to interpret sentences like "Max wins the race". The motivation for a heterogeneous interpretation of "Max wins the race" is that it reflects the intuition that not every part of an event where Max wins the race is itself an event where Max wins the race.

It was argued, however, that the Heterogeneous Strategy does not allow one to give a satisfactory representation of sentences (7) and (8).

- (7) Max ran at 3pm
- (8) Max won the race at 3pm

The analysis of "Max wins the race" must be *homogeneous* rather than heterogeneous. This undermines the *Heterogeneous Strategy* for interpreting the classification of aspect. Even though the Heterogeneous Strategy is intuitively motivated, it is not formally sustainable. The puzzle now is: can *homogeneity* provide a semantic distinction between expressions of different aspectual classes? This puzzle is answered in chapters 6 and 7. But before moving onto this, we will look in detail at the second task connected with the imperfective paradox, i.e. defining the semantics of the progressive. We explore this in the next chapter.

Chapter 3

An Account of the Progressive in Terms of Eventual Outcome

1 Introduction

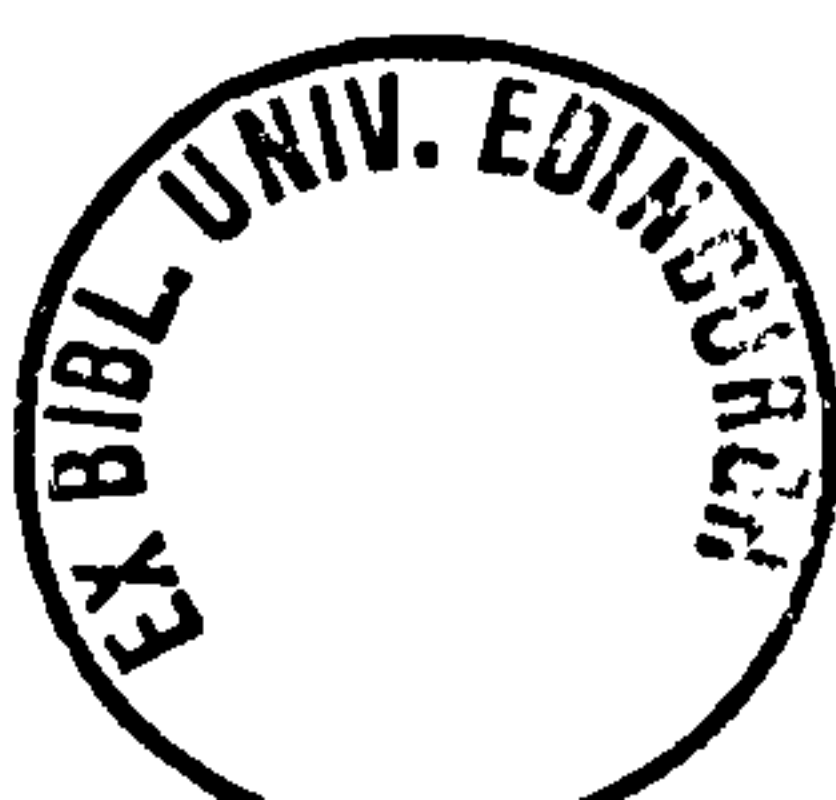
A formal account of the semantics of the progressive must square with its actual use. So let us examine from an intuitive perspective what criteria are used to decide whether a progressive sentence is true. To start with, are there any criteria that one may apply *directly* to the current state of affairs, to discover whether that state of affairs makes a progressive sentence true? Consider sentence (1).

(1) Max is winning the race

It seems that such criteria would be difficult to describe. The states of affairs which make sentence (1) true could amount to almost anything. (1) may be true when Max is ahead, or when he is third but running faster than the athletes in first and second place. If Max has a good reputation as an athlete, then (1) may be true even if Max is last, but his strategy for winning the race is going according to plan.

What property, if any, do all these states of affairs have, that can be regarded as the property making the progressive sentence true? The puzzle is: Given the wealth of states of affairs that can be regarded as an instance of (1), it seems that a search for a common property among them would prove fruitless. However, there is the following strong intuition: (1) is true just in case there is something going on now, *whatever* that is, such that if it were to continue uninterrupted, then the *outcome* would be that Max is the winner of the race.

This intuition indicates that the common property of all the progressive states of affairs may not be found by looking at the state only at the current time; instead one must investigate the *outcome* of the state of affairs. This intuition may offer a strategy to yield the formal semantics of the progressive. The truth conditions placed by the semantic definition of the progressive on the current state of affairs should not be conditions that concern what is going on now, but must be conditions on the *eventual outcome* of what is going on now. I call this strategy in defining the progressive the *Eventual Outcome Strategy*. The object of this chapter is to test whether this



strategy can be formulated.

How would the Eventual Outcome Strategy relate sentences (2) and (3)?

- (2) Max was winning the race
- (3) Max won the race

Intuitively, (3) refers to a process which leads to a culmination. (2) refers to that process, but it does not assert that the culmination of the process occurred.

The idea behind the Eventual Outcome Strategy is to define the semantics of (2) and (3) so that they do *not* place conditions *directly* on what the process leading to the culmination consists of. For example, the semantics of these sentences will not talk of whether Max had a good start to the race, whether he was ahead at the half way stage, and so on. Instead, the process is characterised in the semantics of the progressive in terms of the *culmination*: *Whatever* the process is, *if* it were to continue uninterrupted, then it *would* lead to the culmination. So the definition of the progressive under the Eventual Outcome Strategy essentially involves *modality* of the 'counterfactual' kind.

We have seen that the process (1) refers to is characterised in the Eventual Outcome semantics of the progressive in terms of the culmination, plus some appropriate sense of modality. Given this semantics, any formulation of the strategy must fulfil two tasks. First, it must offer a semantic account of the *culmination* that the process would lead to. Second, it must offer an account of the *modality* in the definition of the progressive; i.e. an explanation of the phrase "if the process were to continue uninterrupted".

The object of this chapter is to test whether the Eventual Outcome Strategy can be formulated, and if so, establish how the formulation would deal with the two tasks at hand. The Eventual Outcome Strategy has been formalised in three theories, (Dowty 1979), (Cooper 1985) and (Hinrichs 1983). We will consider each of these theories in turn.

2 The Consequences of the Eventual Outcome Strategy

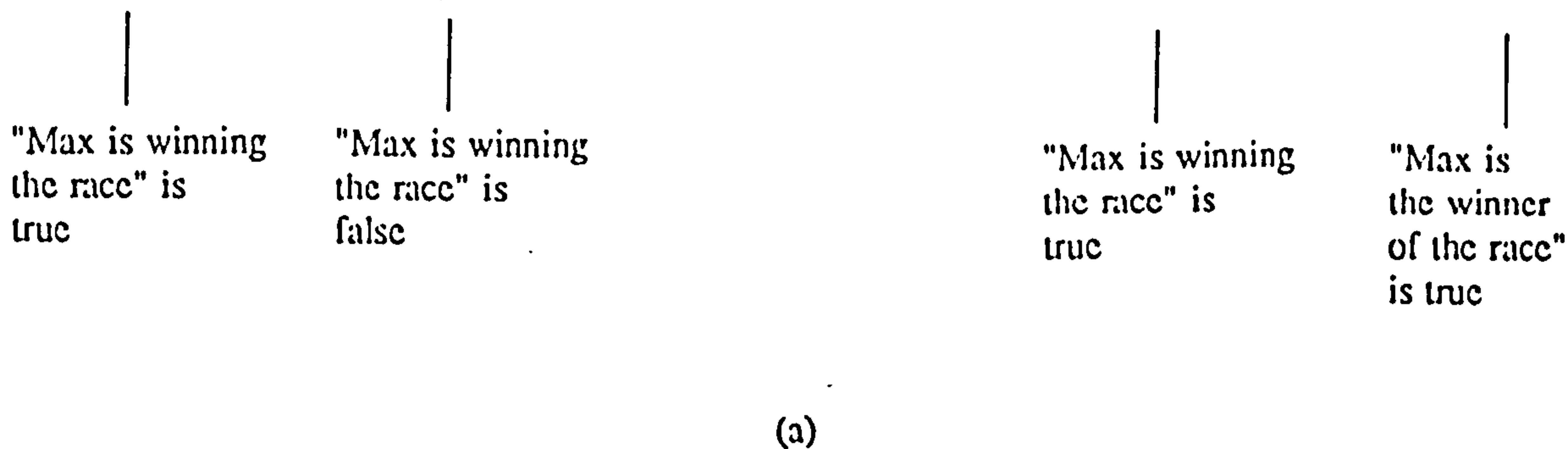
In order to have a perspective from which to test the theories that adopt the Eventual Outcome Strategy, I will now set up a question that concerns the consequences of the strategy.

Consider the following situation: suppose that Max is running in a race of four laps. Suppose he is ahead at the start of the third lap. Then according to intuitions, sentence (1) is true at this

time.

(1) Max is winning the race

Now suppose that at the start of the fourth lap, Max has fallen behind in the race. He is now last, and it looks as though only a miracle could bring him victory. So according to intuitions, sentence (1) is now false. Suppose that, despite everything, Max surges forward half way through the fourth lap to gain first position again. Then according to intuitions (1) is true once again. Now suppose that Max crosses the finish line in first place to win the race. Then according to intuitions, this whole situation is one where sentence (1) is true, and then false, and then true, and then the target state to winning the race (Max is the winner) is true. Therefore, since the above situation is clearly possible, the following temporal structure must depict a possible state of affairs:

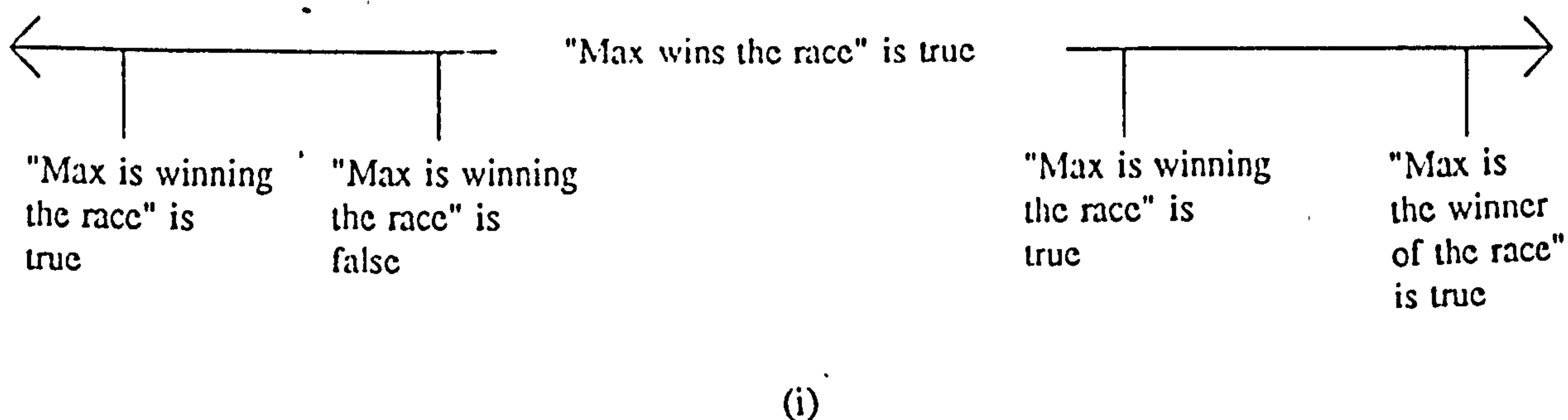


The question now is: when is sentence (4) true in the above state of affairs?

(4) Max wins the race

(4) must be true at *some* time in the above situation, since Max does actually win the race. Suppose that (4) is true with respect to a *period* of time, to reflect the idea that (4) refers to a *process* that goes on over a period of time²³. Will the formulation of the Eventual Outcome Strategy allow this period to contain *all* the times depicted in (a), yielding temporal structure (i)?

²³ In chapter 2, we argued that (4) must be true *only at moments* and *not over periods* of time, if the semantics of (4) is to involve a notion of *culmination*. So in this case, we are considering (4) *not as* involving the notion of a culmination, but only involving the notion of a process.



Clearly, the state of affairs depicted in (a), which any satisfactory semantic theory must deem as possible, is related to the state of affairs depicted in (i), and just how they are related in the theory depends on the semantics of the progressive and the semantics of (4). Our puzzle is: will an Eventual Outcome theory allow for a semantic interpretation of the progressive and (4) that describes the state of affairs depicted in (i)? In the rest of this chapter, I will define the state of affairs depicted in (i) as *consistent* if there is a semantic interpretation of the progressive and (4) that describes that state of affairs, and *inconsistent* if there is no such semantic interpretation of the progressive and (4). So our puzzle can be stated in another way: will an Eventual Outcome theory establish the state of affairs depicted in (i) as consistent or as inconsistent?

The Eventual Outcome Strategy has been formulated in three theories, (Dowty 1979), (Cooper 1985) and (Hinrichs 1983). I will see whether (i) is consistent in each of these theories. We have seen that an Eventual Outcome semantics of the progressive defines the semantics of (1) purely in terms of the culmination, plus some appropriate notion of modality. I will argue that one can obtain an appropriate notion of *modality* only if one establishes that the state of affairs depicted in (i) is *inconsistent*. On the other hand, I will argue that if one is to characterise (1) purely in terms of the culmination, then one must allow (i) to be *consistent*. This exposes a tension in the two tasks that must be tackled in formulating the Eventual Outcome Strategy; defining the appropriate notion of *modality* and defining the semantics of (1) purely in terms of the culmination. I will conclude from this that the Eventual Outcome Strategy is ultimately untenable.

It is important to realise that our argument against the Eventual Outcome Strategy is *independent* of the *intuitions* one might have concerning whether (i) should be consistent or inconsistent. There seems to be something highly counterintuitive in allowing for a semantic interpretation of (4) and (1) that describes the state of affairs depicted in (i). One feels that sentences (4) and (1) should refer to the same process, and so the period of time over which (4)'s process goes on should not contain times at which (1) is false. And yet in (i), (1) is false in that period. So according to intuitions, (i) should be inconsistent. However, it must be stressed that our argument against the

Eventual Outcome Strategy is *not* based on this intuition that (i) should be inconsistent. The argument is based on something slightly stronger. *Any* formulation of the Eventual Outcome Strategy must account for (i) as consistent or as inconsistent. I will argue that *either way*, the formulation fails. In each case, the reasons it fails are *independent* of the intuition that (i) should be inconsistent.

I will consider each of the three Eventual Outcome theories in turn. I start with Dowty's theory.

3 Dowty's Formulation of the Eventual Outcome Strategy

Before describing Dowty's Eventual Outcome definition of the progressive, one must understand his semantic interpretation of non-progressive sentences. Dowty's strategy for analysing these sentences is to formalise Vendler's (1967) classification of aspect. A detailed discussion of Vendler's classification of aspect and Dowty's formulation of it took place in the previous chapter. I am concerned here only with his interpretation of sentences like (4).

(4) Max wins the race

(4) denotes an achievement, and therefore I shall consider here how Dowty interprets achievement sentences.

3.1 Dowty's Semantic Interpretation of Achievements

The logical form of a tenseless achievement sentence is [BECOME Φ], where Φ denotes the state of affairs once the achievement is completed. For example, the logical form of sentence (4) is (4a), where the stative formula $\text{winner}'(\text{max}', \text{race}')$ corresponds to the state that Max is the winner of the race.

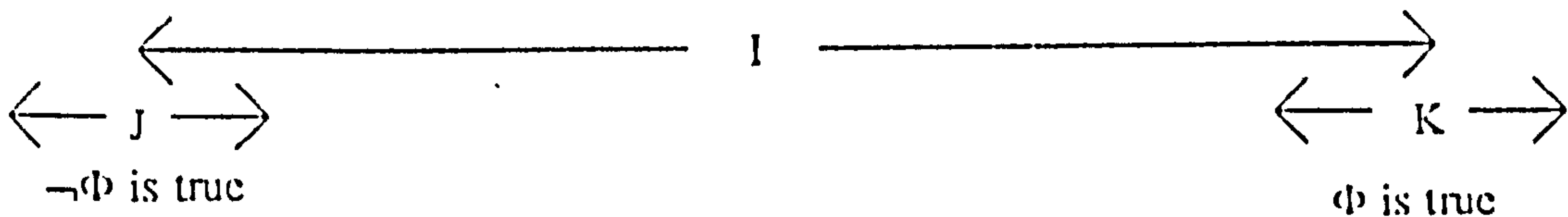
(4a) [BECOME $\text{winner}'(\text{max}', \text{race}')$]

I repeat here the truth definition of the operator BECOME that was discussed in detail in chapter 2.

The Truth Conditions for BECOME

[BECOME Φ] is true at an interval I if and only if there is an interval J containing the initial bound of I such that $\neg\Phi$ is true at J and there is an interval K containing the final bound of I such that Φ is true at K.

The truth of the sentence [BECOME Φ] requires the following temporal structure:



The truth value of [BECOME Φ] at the interval I is determined solely by what goes on at the endpoints of I . No conditions are placed on what goes on *during* the interval I . Thus Dowty avoids defining *directly* in the semantics of (4) what constitutes the process that leads to Max being the winner of the race. This is an essential part of the Eventual Outcome Strategy. There is an abundance of states of affairs that may correspond to the coming about of the target Φ , and Dowty avoids describing these. BECOME does not even define *when* the process leading to the target goes on. Indeed, BECOME does not induce a concept of this sort of process at all. Therefore, an achievement is not interpreted as a structured event, constituting a process leading to a goal.

Clearly, it is not just any state of affairs that deserves to be regarded as the process that leads to the goal. The innovation in the Eventual Outcome Strategy is that the definition of the *progressive* in *modal* terms will reveal when the process goes on.

3.2 Dowty's Analysis of the Progressive

Dowty interprets the progressive as a mixed modal-temporal operator. Its definition is the following:

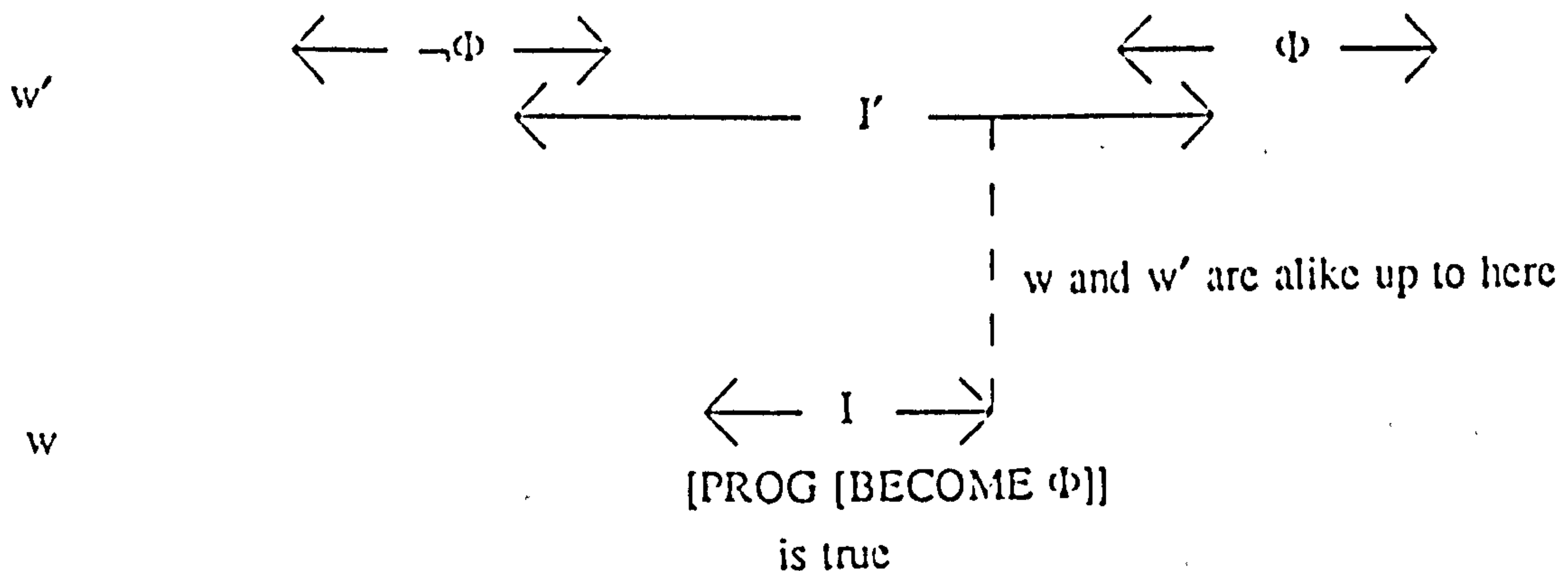
[PROG Φ] is true at an index $\langle I, w \rangle$ if and only if there is an interval I' such that I is contained in I' and I is not a final subinterval of I' , and for all the worlds $w' \in \text{Inr}(\langle I, w \rangle)$, Φ is true at $\langle I', w' \rangle$.

The primitive function Inr is defined as part of the model. It is a two-placed function, taking an interval and a world as its arguments. The evaluation of $\text{Inr}(\langle I, w \rangle)$ gives the *inertia worlds* at $\langle I, w \rangle$, and these characterise the 'natural course of events' at $\langle I, w \rangle$. Intuitively, $\text{Inr}(\langle I, w \rangle)$ denotes the worlds w' that (a) are like the world w up to and including the interval I , and (b) include the natural course of events with respect to the situation in w at I . In other words, an inertia world can be thought of as a world in which nothing *unexpected* happens.

The logical form of (1) is (1a).

- (1) Max is winning the race
 (1a) [PROG [BECOME winner'(max',race')]]

In fact, the progressive forms of *all* achievement sentences are represented by a formula of the form [PROG [BECOME Φ]], which receives the following truth conditions. [PROG [BECOME Φ]] is true in a model M at $\langle I, w \rangle$ just in case there is an interval I' containing I such that I is not a final subinterval of I' , and for all $w' \in \text{Inr}(\langle I, w \rangle)$, [BECOME Φ] is true at $\langle I', w' \rangle$. [BECOME Φ] is true at $\langle I', w' \rangle$ if and only if there is an interval J containing the initial bound of I' such that $\neg\Phi$ is true at $\langle J, w' \rangle$, and there is an interval K containing the final bound of I' such that Φ is true at $\langle K, w' \rangle$. So the truth of [PROG [BECOME Φ]] requires the following temporal structure:



These truth conditions capture the following intuition: if [PROG [BECOME Φ]] is true then *whatever* the current state of affairs is, that state of affairs must lead to the target Φ in the 'natural course of events'.

According to Dowty, the actual world w is not necessarily a member of the set $\text{Inr}(\langle I, w \rangle)$. Therefore the truth of [PROG [BECOME Φ]] at $\langle I, w \rangle$ does not guarantee the truth of [BECOME Φ] in w . Hence there is no entailment from sentence (2) to (3), which is just as required.

- (2) Max was winning the race
 (3) Max won the race

Suppose that [BECOME Φ] is true at an interval I' . Then even though no conditions are placed in the truth conditions of [BECOME Φ] on what goes on during the interval I' , it is possible to evaluate the truth value of [PROG [BECOME Φ]] in terms of [BECOME Φ] at all times during I' . In this way, the definition of the progressive in terms of inertia worlds reveals the structure of

the interval I' at which $[BECOME \Phi]$ is true; i.e. one reveals at what times in I' the process that leads to the target Φ goes on.

Dowty invokes inertia worlds in the analysis of the progressive to specify when the current state of affairs leads to the target. It is the target happening inertially that is crucial to the analysis of the progressive of achievements. It doesn't matter in evaluating (1) whether Max is ahead or in second place at the time in question.

(1) Max is winning the race

Even though there are endless possible actions corresponding to (1), they all have one thing in common, and that is that they inertially lead to the target state.

Dowty's approach seems fruitful, but one cannot adopt it until one fully understands the notion of *modality* invoked in the definition of the progressive. In Dowty's theory, this amounts to solving the following problem. Choose a model M and a world time index $\langle I,w \rangle$. Then what is the set of inertia worlds, $Inr(\langle I,w \rangle)$ in M ? Is the function Inr uniquely defined with respect to the model M ? It is inertia specification that gives the analysis of the progressive its "eventual outcome" properties. The question remains as to whether inertia specification is sufficient for describing what is going on at the time of (1) in a way that squares with our intuitions.

4 Inr and Why (i) is Inconsistent

In order to see how inertia should be specified, we will now ask, relative to Dowty's theory, the question that was posed in section 2. In section 2, I argued that according to intuitions, it is possible for sentence (1) to be true, and then false, and then true, and then Max may go on to win the race. i.e. the situation depicted in (a) is a possible state of affairs:

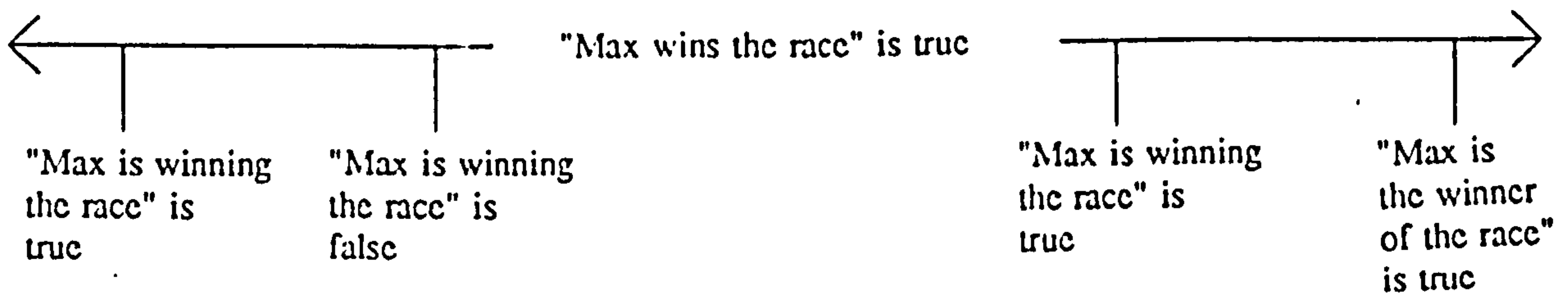


(a)

The question we ask is: when is sentence (4) true in the above?

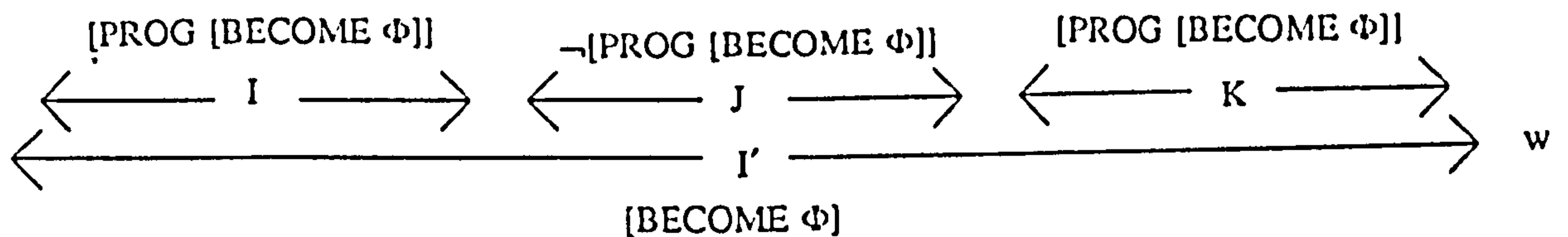
(4) Max wins the race

Can the period with respect to which (4) is true contain the time at which (1) is false? That is, can we have a semantic interpretation of the progressive and (4) that describes the state of affairs depicted in (i) (i.e. in our terminology is (i) consistent)?



(i)

This question amounts to the following in Dowty's theory: can $[\text{PROG} [\text{BECOME } \Phi]]$ (where Φ is the formula $\text{winner}'(\text{max}', \text{race})$) be true at an index $\langle I, w \rangle$, and then false at $\langle J, w \rangle$ and then true at $\langle K, w \rangle$, where I, J and K are contained in an interval I' and $[\text{BECOME } \Phi]$ is true at $\langle I', w \rangle$? In other words, is Dowty's version of structure (i) consistent?



(i)

Given that Dowty places no restrictions on what goes on during the interval I' in the truth definition of $[\text{BECOME } \Phi]$ at I' , this seems like a legitimate question to ask. Whether or not (i) is consistent will depend on the semantics of PROG , and in particular on how the function Inr is defined. The object of this section is to demonstrate that in order for the function Inr to be well-defined, we must ensure that (i) depicts a state of affairs that is *inconsistent*.

To show this, I will assume the hypothesis that (i) is consistent, and show that Inr cannot be well-defined under this hypothesis. Suppose that a model M describes the state of affairs depicted in (i): i.e. $[\text{PROG} [\text{BECOME } \Phi]]$ is true in M at $\langle I, w \rangle$, false in M at $\langle J, w \rangle$ and true in M at $\langle K, w \rangle$, and $[\text{BECOME } \Phi]$ is true in M at $\langle I', w \rangle$, where $I < J < K$, and I, J and K are all contained in I' . Then is w a member of the inertia worlds at $\langle I, w \rangle$ with respect to M ? In exploring this

question, we will reveal whether or not the function Inr which is part of the model M can be uniquely defined. We first examine the consequences of the assumption that w is a member of $\text{Inr}(\langle I, w \rangle)$ in the model M .

4.1 Why the Assumption that w is Inertial is Inadequate

Suppose we assume that w is a member of $\text{Inr}(\langle I, w \rangle)$ in the model M that describes the state of affairs corresponding to (i). Then the resulting interpretation of inertia worlds does not square with the intuitions concerning the progressive. It will be shown that this follows from the fact that for *any* model M' where, like the model M , $[\text{PROG} [\text{BECOME } \Phi]]$ is true at $\langle I, w \rangle$ and false at $\langle J, w \rangle$ where $I < J$, it is *not possible* to maintain the supposition that w is inertial at $\langle I, w \rangle$ in M' .

I now argue for this conclusion by considering such a model M' ; it will be shown that w cannot be a member of $\text{Inr}(\langle I, w \rangle)$ in M' . Consider the following model M' : suppose that Max is running in a race at $\langle I', w \rangle$, and suppose that he falls over at $\langle J, w \rangle$, where J is contained in I' . Since Max is lying flat on his face on the track at $\langle J, w \rangle$, according to intuitions, (5), whose logical form is (5a), is true at $\langle J, w \rangle$ with respect to M' .

- (5) It is not the case that Max is winning the race
 (5a) $\neg[\text{PROG} [\text{BECOME } \text{winner}'(\text{max}', \text{race}^*)]]$

Suppose in the model M' that before Max fell over at $\langle J, w \rangle$, he was winning the race. i.e. (1a) is true with respect to M' at $\langle I, w \rangle$, where $I < J$ and I is contained in I' .

- (1a) $[\text{PROG} [\text{BECOME } \text{winner}'(\text{max}', \text{race}^*)]]$

Then given these assumptions on M' , is w inertial at $\langle I, w \rangle$ in M' ?

According to intuitions, after the progressive action has been interrupted, *anything* can happen. But the progressive action *is* interrupted in the model M' at $\langle J, w \rangle$ because Max falls over at $\langle J, w \rangle$, and so *anything* that happens after J in w is consistent with the truth of (1a) at $\langle I, w \rangle$ where $I < J$. In particular, the truth of (1a) in the model M' at $\langle I, w \rangle$ is consistent with "Max wins the race" being false in w . However, if w is inertial at $\langle I, w \rangle$ in M' , then by the definition of PROG, the truth of (1a) at $\langle I, w \rangle$ *requires* that Max wins the race in w . This is contrary to intuitions, and therefore one *cannot* assume that w is inertial at $\langle I, w \rangle$ in the model M' , if the definition of the progressive is to agree with its actual use.

This model M' describes a state of affairs that is like the state of affairs depicted in (i), in that the formula $[\text{PROG} [\text{BECOME } \Phi]]$ is true at $\langle I, w \rangle$ and then false at $\langle J, w \rangle$, where $J > I$. Therefore, the argument presented here that w must not be inertial at $\langle I, w \rangle$ in M' supports the claim that w *must not* be inertial at $\langle I, w \rangle$ in the model M with respect to which the state of affairs in (i) is true. What are the consequences of this?

4.2 Circularity

Given that w cannot be inertial at $\langle I, w \rangle$ in the model M with respect to which the state of affairs in (i) is true, I will now show that the two-place function Inr is not well-defined. Furthermore, if one were to try to modify the function to make it well-defined, then the analysis of the progressive would be reduced to circularity.

In order to show that Inr is not well-defined, we must establish in more depth how to interpret the phrase "an inertia world is one where the state of affairs continues uninterrupted". In the semantic evaluation of a progressive sentence, say (1),

- (1) Max is winning the race

do we assume (a) that a world w' is inertial at $\langle I, w \rangle$ with respect to a model M if and only if *all* the states of affairs at $\langle I, w \rangle$ 'continue uninterrupted' in w' , or (b) that a world w' is inertial at $\langle I, w \rangle$ with respect to M if and only if the 'winning' event 'continues uninterrupted' in w' (so other events may be interrupted in w')? The difference between assumptions (a) and (b) is clear. Assumption (a) entails that *absolutely nothing* can be interrupted in an inertial world, and (b) entails that in the semantic evaluation of (1), only the winning event is uninterrupted. Furthermore, (a) and (b) are the only two possible assumptions, since there are no other plausible ways of picking the inertia worlds if they are to capture a notion of events continuing uninterrupted.

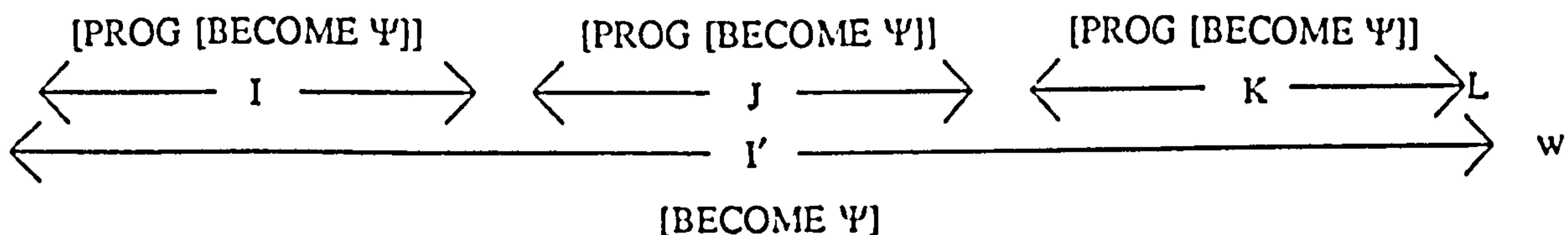
We will now show that assumption (a) is not sustainable, and so inertia worlds must be chosen according to assumption (b). We will demonstrate that assumption (a) is inadequate by means of the following example: suppose that sentences (1) and (6) are both true at $\langle I, w \rangle$ with respect to a model M' .

- (6) John is sabotaging the race (by planting a bomb on the race track that is due to blow up Max before the race is completed).

Let us consider what will happen if the two corresponding events 'continue uninterrupted'. If John

succeeds in sabotaging the race, i.e. the bomb goes off and the race is never completed, then Max will not win the race, i.e. Max's winning will be interrupted. On the other hand, if Max's winning the race continues uninterrupted so that he becomes the winner of the race, then John did not succeed in sabotaging the race. So there is no world where both the state of affairs corresponding to (1) and the state of affairs corresponding to (6) continue uninterrupted to the target. Therefore, if assumption (a) is correct, then the set of inertia worlds at $\langle I, w \rangle$ with respect to this model M' will be empty. But this is clearly undesirable, since it follows from this by the definition of PROG that *any* progressive sentence is true at $\langle I, w \rangle$ with respect to M' . Hence assumption (a) is not satisfactory and assumption (b) must hold.

We will now show that since assumption (b) holds, Inr is not well-defined. Suppose that the model M is as described above. That is, M corresponds to the state of affairs in (i). Suppose furthermore that in M , $[\text{BECOME } \Psi]$ is true at $\langle I', w \rangle$ for some state Ψ (where Ψ is not related to Φ), and $[\text{PROG } [\text{BECOME } \Psi]]$ is true in w at every interval contained in I' before the time L at which Ψ is true. So the model M corresponds to temporal structure (ii) as well as (i) in w .



The state of affairs in (ii) 'continues uninterrupted', since the progressive action continues from the interval I to the time when the target Ψ is true. According to assumption (b), therefore, w must be a member of the inertia worlds at $\langle I, w \rangle$ with respect to the model M in order to obtain the right truth conditions of $[\text{PROG } [\text{BECOME } \Psi]]$. But we concluded in the previous section that w *cannot* be inertial at $\langle I, w \rangle$ if we are to gain the right truth conditions for $[\text{PROG } [\text{BECOME } \Phi]]$. Therefore we have a situation where w is in $\text{Inr}(\langle I, w \rangle)$ with respect to M and w is not in $\text{Inr}(\langle I, w \rangle)$ with respect to M . Hence the two-place function Inr that takes an interval and a world as its arguments is *not well-defined*.

How may one modify the function Inr , in order to make it well-defined? If Inr is to be well-defined, then it must be defined relative to *formulae*, as well as intervals and worlds, so that inertia specification in the model M can distinguish the inertial status of w in the semantic evaluations of $[\text{PROG } [\text{BECOME } \Phi]]$ and $[\text{PROG } [\text{BECOME } \Psi]]$. But which formulae are appropriate as input

for Inr?

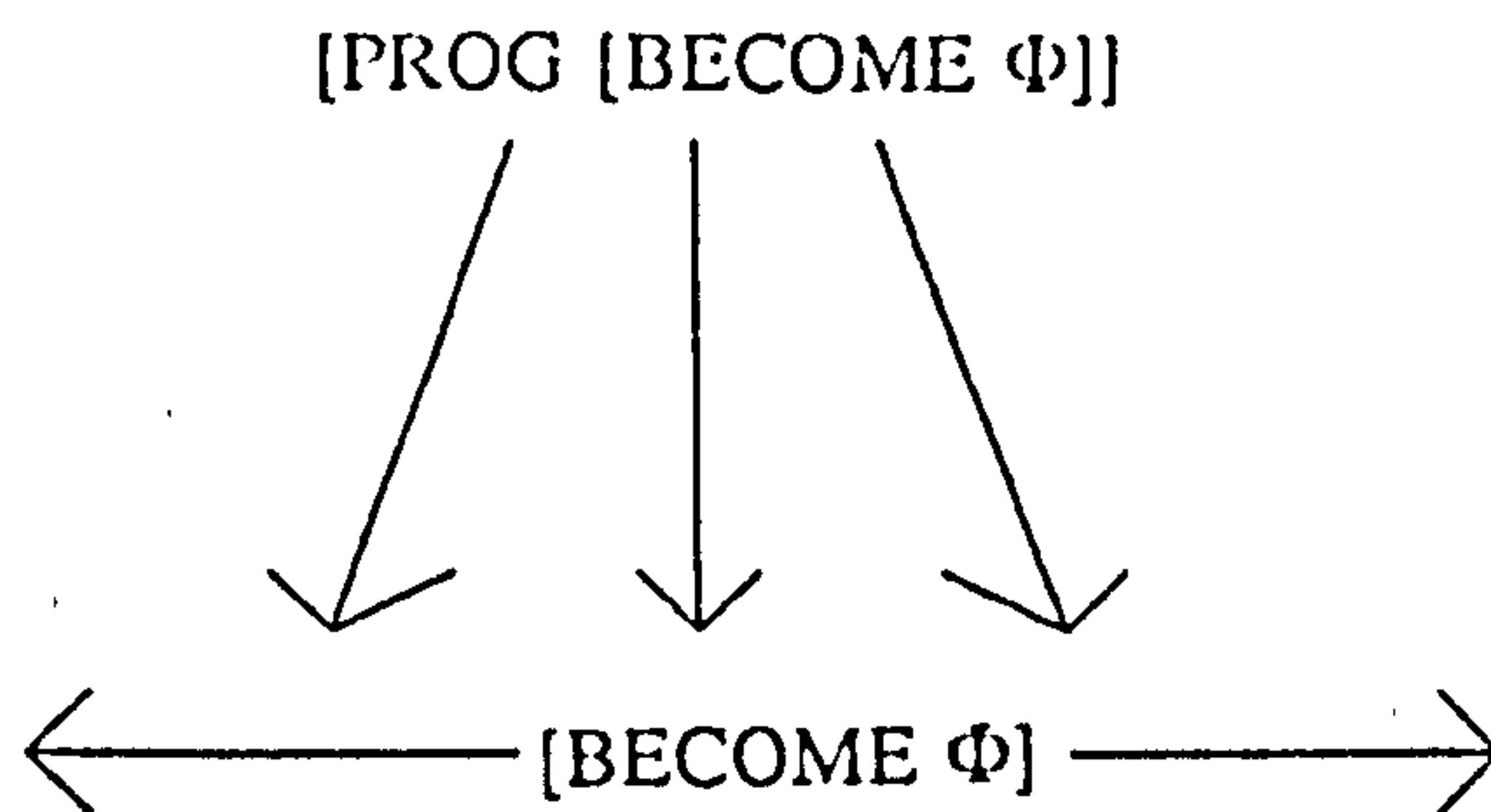
[PROG [BECOME Ψ]] requires w to be inertial at $\langle I, w \rangle$ in the model M because we have assumed that [PROG [BECOME Ψ]] is *true* at $\langle J', w \rangle$ in the model M for every interval J' contained in I' . [PROG [BECOME Φ]] requires w not to be inertial at $\langle I, w \rangle$ in the model M because we have assumed that [PROG [BECOME Φ]] is *false* in the model M at some $\langle J, w \rangle$ where $I < J$ and J is contained in I' (cf. section 5.1). Therefore, in order for Inr to predict that w is inertial at $\langle I, w \rangle$ in the M in the semantic evaluation of [PROG [BECOME Ψ]] but not in the semantic evaluation of [PROG [BECOME Φ]], Inr must be defined relative to the truth value of the progressive sentence at the intervals contained in I' . i.e. Inr must be a function whose arguments for the semantic evaluation of [PROG [BECOME Φ]] are I , w , and the truth values of [PROG [BECOME Φ]] at times contained in I' .²⁴

This leaves us with the following problem in specifying Inr. In order to obtain a satisfactory specification of the function Inr, it must include as arguments the truth values of [PROG [BECOME Φ]]. But one cannot know the truth values of [PROG [BECOME Φ]] until one has successfully completed specifying Inr. Specifying inertia is thus reduced to *circularity*.

We have shown that in the model M that describes the state of affairs depicted in (i), the two-place function Inr that takes an interval and a world as its arguments is not well-defined. Furthermore, if one were to try and make it well-defined, then the analysis of the progressive would be reduced to circularity. Therefore, the function Inr cannot be defined with respect to the model M . In other words, if (i) is consistent, then one cannot successfully specify Inr.

One cannot specify Inr under the assumption that (i) is consistent. But specifying Inr is crucial to defining the progressive in terms of eventual outcome in Dowty's theory. Therefore, to preserve the Eventual Outcome Strategy, one must place conditions on the semantics of the progressive and the semantics of BECOME to ensure that (i) is *inconsistent*. In other words, the semantics of the progressive and of BECOME must ensure that if [BECOME Φ] is true at an interval I , then [PROG [BECOME Φ]] is true at *all intervals* contained in I : i.e. the state of affairs must be that depicted in (iii) below.

²⁴ Notice that it is the *progressive* sentence that must be the argument to Inr, because the 'bare' formulae Φ and Ψ may agree in semantic value in w .



(iii)

5 How to Define (i) as Inconsistent

How may one guarantee that if $[\text{BECOME } \Phi]$ is true at an interval I , then $[\text{PROG } [\text{BECOME } \Phi]]$ is true at all subintervals of I ? I will argue that this temporal structure cannot be derived from Dowty's current semantics for BECOME. Furthermore, it cannot be derived by revising the semantics of BECOME without undermining the Eventual Outcome Strategy.

5.1 The Current Semantics for BECOME

Suppose one fixes Dowty's semantics for BECOME, and suppose that the function Inr is defined so that if $[\text{BECOME } \Phi]$ is true at the interval I , then $[\text{PROG } [\text{BECOME } \Phi]]$ is true at every interval contained in I . Then although placing conditions on inertia specification to guarantee this temporal structure may be technically viable, it is materially inadequate, given the current truth conditions for BECOME. To show this, I will construct a model M'' where the truth of (1) in M'' does not agree with its actual use.

Consider the model M'' where Max is born at $\langle N, w \rangle$, and (4a), which is the representation of (4) is true at $\langle I', w \rangle$, where I' spans twenty years and contains N .

- (4) Max wins the race
 (4a) $[\text{BECOME winner}'(\text{max}', \text{race})]$

Such a model is admissible with the current truth conditions for BECOME²⁵. If inertia is specified

²⁵ Dowty offers alternative truth conditions for BECOME (call the new operator BECOME_1), where $[\text{BECOME}_1 \Phi]$ is supposed to identify the *smallest* interval over which the change of state from $\neg\Phi$ to Φ takes place. The definition of BECOME_1 requires Dowty to assume that there are truth value gaps; i.e. Φ must be neither true nor false at all intervals properly contained in the interval I at which $[\text{BECOME}_1 \Phi]$ is true. But Dowty does not define *when* a sentence like "Max is the

so that (1a), which is the representation of (1), is true at all times during the interval I' , then (1a) is true in M'' at $\langle N, w \rangle$, the time when Max is born.

- (1) Max is winning the race
 (1a) [PROG [BECOME winner'(max', race')]]

This does not accord with the actual use of the progressive. The discrepancy between the truth value of the progressive and its actual use is a direct result of the fact that BECOME does not yield an interpretation of (4) as a process that leads to culmination.

The required relationship between [BECOME Φ] and [PROG [BECOME Φ]] cannot be obtained with the current semantics of BECOME. The question now is: how should the semantics of BECOME be modified?

5.2 A Change to BECOME

How should Dowty's definition of BECOME be revised to ensure that (i) is inconsistent? In other words, how should BECOME be modified so that [PROG [BECOME Φ]] is true throughout any interval I at which [BECOME Φ] is true, in such a way that the truth values assigned by the theory to [PROG [BECOME Φ]] square with the actual use of the progressive? To obtain such a semantics for BECOME the following must hold: if (4a), which represents (4), is true at an interval I , then the semantic definition of BECOME must ensure that the state of affairs during I is one where we would naturally assert (1) as true, e.g. Max is ahead in the race, or he is third but running faster than the athletes in first and second place, etc. In other words, the semantics of BECOME must ensure that all the intervals contained in I are ones where the process that leads to the target is going on, and to achieve this, the semantics of BECOME must *characterise* the process that leads to the target.

The Eventual Outcome Strategy is an attempt to characterise the process that leads to the target in terms of eventual outcome. Can one define the process in terms of eventual outcome within the semantics of BECOME? The Eventual Outcome characterisation that Dowty offers of the process that leads to the target Φ is given in the semantics of [PROG [BECOME Φ]], which invokes the semantics of BECOME. So one cannot use this definition to define BECOME, or the analysis is reduced to circularity. Instead, the definition of BECOME must characterise the process that leads

winner of the race" (whose formal representation is winner'(max', race')) is neither true nor false. So there is still nothing in the truth conditions of BECOME₁ that bars the model M'' from being admissible.

to the target by placing conditions *directly* on what the process consists of, i.e. it must assert in the case of (4) that the process goes on only if Max is ahead, or third but running faster than the athletes in first and second place, etc.

This goes against the grain of the Eventual Outcome strategy. The aim is to characterise the process purely in terms of *eventual outcome*. There must be *no* conditions placed *directly* on what the process consists of. Therefore, one undermines the Eventual Outcome Strategy, if the semantics for (4) characterises the process by placing conditions *directly* on what the process consists of. But we have argued that having such a semantics for (4) is the only way to explain that the state of affairs depicted in (i) is inconsistent. Hence one cannot modify Dowty's definition of BECOME in order to ensure that (i) is inconsistent without undermining the Eventual Outcome Strategy.

I have argued that one cannot explain that (i) is inconsistent in Dowty's theory with his current semantics for BECOME. But I have shown here that if one attempts to revise the semantics of BECOME to explain the inconsistency of (i), then one undermines the Eventual Outcome Strategy. Therefore, (i) must be *consistent*.

But this is in conflict with the argument given in section 5, that in order to give a satisfactory specification of Inr, (i) must be an *inconsistent* state of affairs. The semantics of BECOME and the specification of Inr are both essential ingredients to Dowty's formulation of the Eventual Outcome Strategy. But the semantics of BECOME requires (i) to be *consistent* and the specification of Inr requires (i) to be *inconsistent*. Therefore, Dowty's formulation of the Eventual Outcome Strategy fails.

Cooper offers an alternative formulation of the Eventual Outcome Strategy, this time within the framework of *situation semantics*. Can Cooper succeed where Dowty failed? To answer this question, we will investigate his semantic analysis of sentences (1) and (4).

- (1) Max is winning the race
- (4) Max wins the race

6 Cooper's Formulation of the Eventual Outcome Strategy

Before describing Cooper's Eventual Outcome definition of the progressive, we will review his interpretation of sentence (4). Cooper represents the semantics of (4) by formulating Vendler's classification of verbs in *situation semantics*. Let us review the general framework in which

Cooper's theory is set.

6.1 The Tools

Individuals, n-place relations and locations constitute the primitive objects in the semantic framework. Locations are spatio-temporal entities, e.g. the time spanning from 2pm to 3pm on 30th April 1988 at the Centre for Cognitive Science is a location. There are also indeterminates over locations and individuals; these play the role of variables.

The basic constructs out of these objects are *fact-types*, i.e. structures of the form

$$\langle l, r, x_1, \dots, x_n, i \rangle$$

where l is a location (or location indeterminate) r is an n -place relation, x_1, \dots, x_n are individuals (or individual indeterminates), and i is either 0 or 1 (0 corresponds to "false" and 1 corresponds to "true"). For example, the fact-type $\langle l, \text{win}, \text{max}, \text{race}, 1 \rangle$ is paraphrased as "the fact-type that Max wins the race at location l is true". Facts are those fact-types that do not contain any indeterminates. So, for example, $\langle l, \text{win}, \text{max}, \text{race}, 1 \rangle$ is a fact as well as a fact-type. Cooper names fact-types with determinate locations *located* or *tensed* fact-types, and fact-types with location indeterminates are *unlocated* or *untensed* fact-types.

A set of fact-types is a *situation-type*. For example, the situation-type s defined below

$$s \quad \{ \langle l, \text{win}, \text{max}, \text{race}, 1 \rangle, \langle l, \text{draw}, \text{john}, \text{circle}, 1 \rangle \}$$

is paraphrased as the situation-type where Max wins the race at location l is true, and John draws a circle at location l is true. A situation-type that constitutes a set of tensed fact-types is a *history* (hence s is a history). A situation-type that constitutes a set of untensed fact-types is an *unlocated* or *untensed* situation-type. A history where all the fact-types share the same location is referred to as a *state of affairs* (hence s is a state of affairs).

Cooper interprets tensed sentences deictically. He introduces a *connection* function c defined on tensed verbs so that $c(\text{loved})$ provides a location in space-time where the relation "love" is to be considered. The sentence "John loved Mary" is interpreted in the following way, where l_d is the *discourse location* (identified by the discourse state of affairs d):

John loved Mary

describes a history h with respect to connection c and discourse state of affairs d if and only if h contains the fact
 $\langle c(\text{loved}), \text{love}, \text{John}, \text{Mary}, 1 \rangle$
 where $c(\text{loved}) < 1_d$.

The interpretation of a sentence in Cooper's framework is concerned with whether sentences describe histories rather than with truth values per se. Finding out whether the sentence is true or not involves an additional step of evaluation, seeing whether the histories described match the world or not. A sentence is true (with respect to some structure of situations) if it describes a history which is realised or actual (in that structure of situations). A sentence is false if its negation describes histories that are all realised or actual.

It must be stressed that as yet, situation semantics has no notion of logical consequence. So strictly speaking, there is no way of dealing with the imperfective paradox, since this is a problem of entailment. In defining the semantics of the progressive, Cooper is answering the following question: If a notion of logical consequence were to emerge, then what would the definition of the progressive have to look like in order to solve the imperfective paradox with that theory of logical consequence? Cooper uses the Eventual Outcome Strategy to define the progressive. We will argue that *no matter what* theory of logical consequence situation semantics might end up with, this definition of the progressive won't work.

6.2 The Structural Constraints on the Aspectual Classes

Having reviewed some basic groundwork, let us examine Cooper's interpretation of sentence (4).

(4) Max wins the race

The semantics of (4) rests on his formulation of Vendler's classification of aspect²⁶.

According to Vendler, (4) denotes an achievement. However, in Cooper's account it must be possible to classify it as an accomplishment sentence. This is because Cooper's semantic interpretation of achievement sentences predicts that the progressive form of an achievement sentence is

²⁶ This formulation trades on an idea first introduced by Quine and developed by Carlson; the distinction between individuals and stages of individuals (Carlson 1977, Quine 1960). Cooper uses this distinction to explain why progressives of statives, such as "Max is loving Mary", are anomalous. The semantics of progressives of statives do not concern me in this chapter however. So I will simplify Cooper's account by dropping the distinction between individuals and stages of individuals.

always false, and clearly, (1) can be true.

(1) Max is winning the race

Therefore I will assume that (4) is subject to Cooper's semantic interpretation of accomplishments rather than achievements.

Cooper offers a series of what he calls *structural constraints* to distinguish the semantics of expressions of different aspectual classes. These constraints describe the different kinds of locations at which relations from the different aspectual classes can hold. The structural constraint on realised histories containing *accomplishment* relations is given below:

Temporal Groundedness

If r is an accomplishment relation then any realised history which contains the fact

$\langle l, r, x_1, \dots, x_n, l \rangle$
does *not* also contain the fact

$\langle l', r, x_1, \dots, x_n, l \rangle$
where l' is properlyⁿ temporally included in l ,

For example, the fact (4a), which represents (4) (for the location l determined by the connection function c), is subject to the constraint described in *Temporal Groundedness*.

(4) Max wins the race

(4a) $\langle l, \text{win}, \text{max}, \text{race}, l \rangle$

In words, Temporal Groundedness asserts that if Max wins the race at location l , then there is no location l' temporally included in that location at which Max wins the race: this is meant to reflect the intuition that any part of an event where Max wins the race is not itself an event where Max wins the race. Cooper later revises this constraint to a more sophisticated version. The revisions have no bearing on the Eventual Outcome Strategy, however, and so I shall preserve the above constraint.

Temporal Groundedness does not place any conditions on the times *during* the location l at which the accomplishment relation holds, save that the target should not have already been reached. Thus Cooper avoids defining *directly* in the semantics of (4) what constitutes the process that leads to Max being the winner of the race. This is an essential part of the Eventual Outcome Strategy. There is an abundance of states of affairs that may correspond to the coming about of the target, and Cooper wants to avoid describing these. Temporal Groundedness does not even define *when* the process leading to the target goes on. Indeed, Temporal Groundedness does not induce a concept of this sort of process at all. Therefore, an accomplishment is not interpreted as a "structured"

event, constituting a process leading to a goal.

We have now seen how Cooper defines the semantics of (4) without defining directly what the process leading to the target consists of. Cooper's theory is different from Dowty's, for they are stated in different frameworks. Nevertheless, there are striking similarities in their semantics for (4). Dowty places no restrictions on the state of affairs *during* the intervals at which (4) is true. In Cooper's theory, *Temporal Groundedness* places no restrictions on the state of affairs *during* the locations at which the accomplishment relation "win" holds.

Clearly, it is not just any state of affairs that deserves to be regarded as the process that leads to the goal. The innovation in the Eventual Outcome Strategy is that the definition of the *progressive* in *modal* terms will reveal when the process goes on.

6.3 Cooper's Analysis of the Progressive

Cooper provides a semantic definition of the progressive auxiliary "be". He represents it as a relation between an individual and the property represented by a verb phrase. Verb phrases represent pairs consisting of an indeterminate (which are represented by symbols in bold type) and a situation-type; e.g. the verb-phrase "win the race" is represented as $\langle a, \{\langle l, \text{win}, a, \text{race}, 1 \rangle\} \rangle$. One might refer to the property informally as "the property of being an a such that a wins the race" (this is analogous to λ -abstraction). The interpretation of "Max is winning the race" is as follows:

Max is winning the race
describes a history h with respect to connection c and discourse state of affairs d if and only if h contains the fact
 $\langle c(is), \text{be}, \text{max}, P, 1 \rangle$
where $c(is) = l_d$
and P is the property represented by the VP "wins the race" with respect to d and c ,
i.e. $\langle a, \{\langle l, \text{win}, a, \text{race}, 1 \rangle\} \rangle$.

The above describes the logical structure of progressive sentences. The semantic interpretation of the relation "be" takes the form of further structural constraints.

Control Constraint on "be"

If any realised history h contains the fact
 $\langle l, \text{be}, x, P, i \rangle$
(where i is either 0 or 1)
then h also contains the fact
 $\langle l, \text{be}, P[a/x], i \rangle$
(where a is the subject indeterminate in P).

$P[a/x]$ means "P with x substituted for the indeterminate a " (this corresponds to λ -reduction). For example, the above constraint on "be" entails that if a realised history h contains the fact

$\langle l, \text{be}, \text{max}, \langle a, \{ \langle l, \text{win}, a, \text{race}, l \rangle \} \rangle, l \rangle$ (this corresponds to "Max is winning the race"), then h also contains the fact $\langle l, \text{be}+, \{ \langle l, \text{win}, \text{max}, \text{race}, l \rangle \}, l \rangle$.

In addition to the above constraint on "be", Cooper describes a structural constraint on "be+" which relates all the progressive sentences to the corresponding non-progressive ones. This constraint invokes the *consistent extension* of a state of affairs (where consistency here is *not* to be confused with *logical* consistency). An extension of a state of affairs is simply a history which is a superset of that state of affairs, and a *consistent* extension of a state of affairs is a certain kind of extension, the role of which is to define when the state of affairs 'continues uninterrupted'. The structural constraint on be+ is defined below, where $f[l]$ represents a fact-type containing the location indeterminate l , and the consistent extension of h at l is the consistent extension of the state of affairs that contains all and only the fact-types in h with location l ²⁷.

Structural Constraint on "be+"

If any realised history h contains the fact

$\langle l, \text{be}+, \{ f_1[l_1], \dots, f_n[l_n] \}, l \rangle$

then the consistent extension of h at l contains this fact and also the facts

$f_1[l_1/l], \dots, f_n[l_n/l]$
where l_1, \dots, l_n include l .

This constraint on be+ is supposed to capture the following intuition: if (1) is true, then *whatever* the current state of affairs is, that state of affairs must lead to Max being the winner of the race if it continues uninterrupted. To see exactly how the analysis does this, let us examine the relationship between sentences (1) and (4) that arises from the above constraint. Sentence (1) is represented by the fact-type (1a), for the appropriate location l determined by connection c .

(1a) $\langle l, \text{be}, \text{max}, \langle a, \{ \langle l', \text{win}, a, \text{race}, l \rangle \} \rangle, l \rangle$

By the control constraint on "be", a realised history h contains (1a) only if it contains the fact (1b).

²⁷ This is Cooper's revised structural constraint on "be+". The original account invoked *existential quantification* over consistent extensions. This proved problematic for sentences (i) and (ii).

- (i) The coin is coming up heads
- (ii) The coin is coming up tails

So Cooper suggests that any history h at location l invokes *only one* consistent extension. Cooper has suggested in conversation that the term "consistency" used here should be equated with logical consistency. This cannot be sustained, however, since there is more than one logically consistent extension of a history h at location l , and the consistent extension of h at l referred to in the structural constraint on be+ is unique. So Cooper's use of consistency in be+ should not be confused with logical consistency.

(1b) $\langle l, \text{be+}, \{ \langle l', \text{win}, \text{max}, \text{race}, l \rangle \}, l \rangle$

By the structural constraint on "be+", h contains (1b) only if the consistent extension of h at l that contains the fact (1b) also contains (4a) for some location l' that includes l.

(4a) $\langle l', \text{win}, \text{max}, \text{race}, l \rangle$

(4a) is the representation of (4).

(4) Max wins the race

Thus if (1) describes the state of affairs defined by the history h at location l, i.e. the state of affairs that contains all and only the fact-types in h with location l, then (4) describes the *consistent extension* of that state of affairs. Thus the role of consistent extensions is to tell us when the state of affairs 'continues uninterrupted'. But even if h is realised, it is not necessarily the case that the consistent extension of the state of affairs defined by h at l is realised. Hence there is no entailment from sentence (1) to (4).

Cooper's analysis of the progressive bears a striking resemblance to that of Dowty (Dowty 1979). Dowty defines the progressive with the use of a primitive accessibility relation termed *inertia*, the role of which is to define when the current state of affairs 'continues uninterrupted'. Cooper defines the progressive with the use of a primitive extensibility relation termed *consistency*, the role of which is also to define when the current state of affairs 'continues uninterrupted'.

Even though Cooper's Eventual Outcome Strategy seems fruitful, one cannot adopt it until one fully understands the notion of *modality* involved. In Cooper's theory, this amounts to solving the following problem: given the history h and location l, what is the consistent extension of the state of affairs defined by h at l? Cooper claims that the consistent extension of the discourse history at the discourse location l_d is unique. Therefore it must be possible to define a (possibly partial) function "Ext" on the cross product of histories and locations, which for each pair (h,l) picks out the unique history h' that is the consistent extension of the state of affairs defined by h at l. The structural constraint on "be+" may refer to this function Ext as follows:

If any realised history h contains the fact
 $\langle l, \text{be+}, \{ f_1[l_1], \dots, f_n[l_n] \}, l \rangle$
 then $\text{Ext}(h, l)$ contains this fact and also the facts
 $f_1[l_1/l], \dots, f_n[l_n/l]$
 where l_1, \dots, l_n include l.

The question remains as to whether the specification of the function Ext is sufficient for describing what is going on at the time of (1) in a way that squares with intuitions. This question is analogous to the question that Dowty faced: can one specify the function Inr? We concluded that one could not specify Inr; it was not a well-defined function. Can Cooper do any better? Is the function Ext well-defined?

7 Ext and Why (i) is Inconsistent

In order to see how Ext should be defined, we will now ask relative to Cooper's theory the same question that we asked relative to Dowty's theory, i.e. the question that was posed in section 2. In section 2, I argued that according to intuitions, it is possible for (1) to be true, and then false, and then true, and then Max may go on to win the race.

(1) Max is winning the race

That is, the state of affairs depicted in (a) is possible.

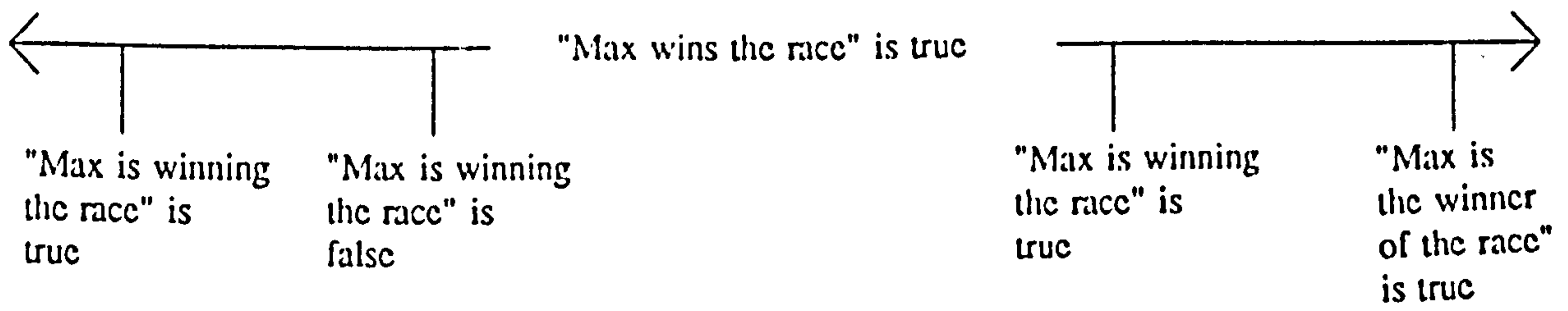


(a)

The question is: when is (4) true relative to this situation?

(4) Max wins the race

Can the period at which (4) is true contain the time at which (1) is false? i.e. Is the situation depicted in (i) consistent?

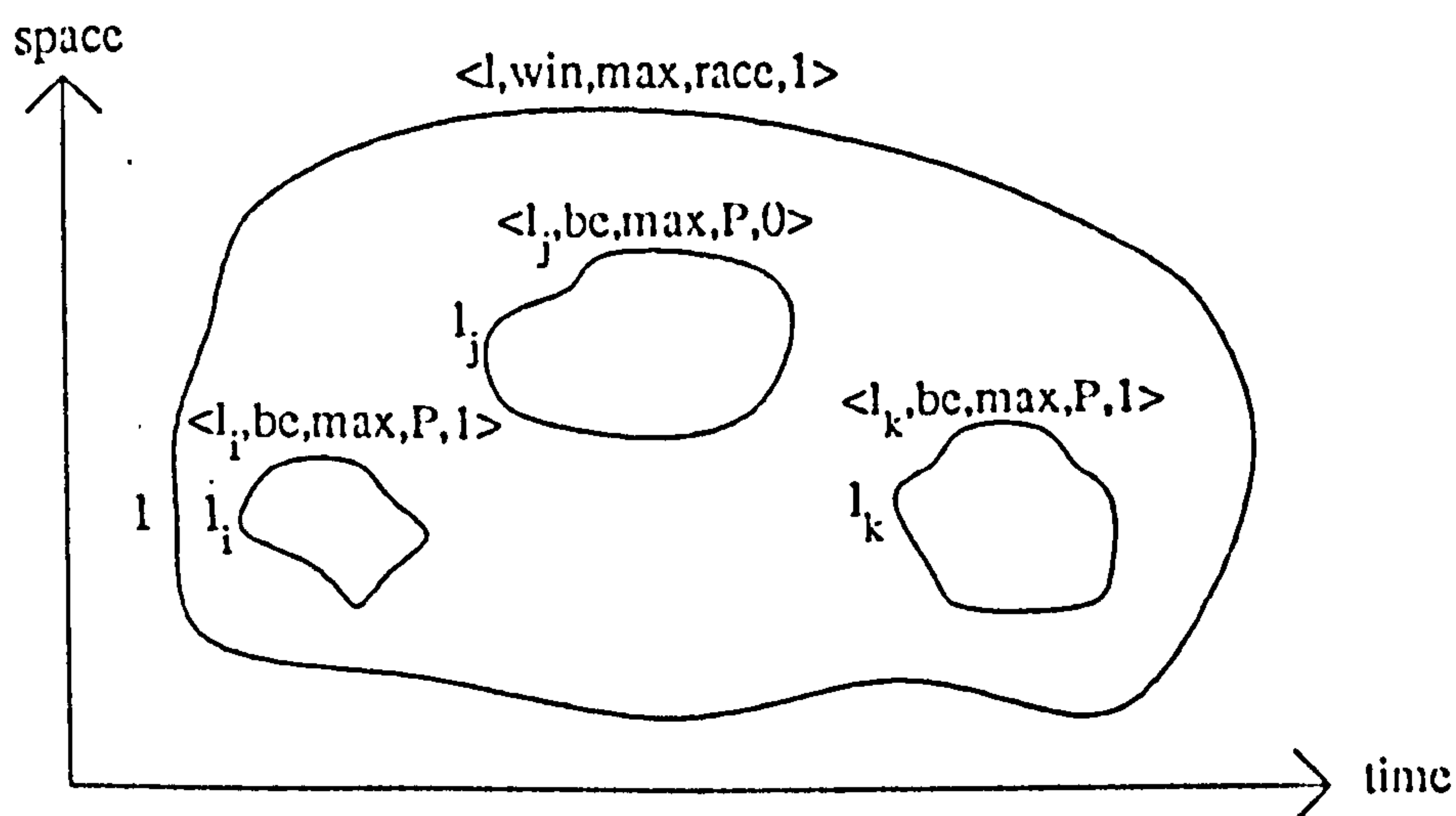


(i)

This question amounts to the following in Cooper's theory: Let the history h contain the facts (1a) (representing (1)), (5a) (representing (5)), (1b) (representing (1) again) and (4a) (representing (4)), where P represents "wins the race", l_i , l_j and l_k are contained in l , and l_i temporally precedes l_j , which temporally precedes l_k .

- (1) Max is winning the race
- (1a) $\langle l_i, bc, max, P, 1 \rangle$
- (5) It is not the case that Max is winning the race
- (5a) $\langle l_j, bc, max, P, 0 \rangle$
- (1b) $\langle l_k, bc, max, P, 1 \rangle$
- (4) Max wins the race
- (4a) $\langle l, win, max, race, 1 \rangle$

So h depicts location structure (i) below:



(i)

Then can the history h be realised?

Given that Cooper places no restrictions on what goes on during the location l at which the relation "win" holds, this seems like a legitimate question to ask. Whether or not h can be realised depends on the semantics of the progressive, and in particular on how the function Ext is defined. The object of this section is to demonstrate that in order for the function Ext to be well-defined, the history h that describes (i) *must not ever* be realised, i.e. h must be 'inconsistent'.

To show this, I will assume the hypothesis that h *can* be realised and show that Ext cannot be defined under this hypothesis. Suppose that the history h that describes (i) is realised. Then is this history h that describes (i) the consistent extension of h at l_i ? In exploring this question, we will reveal whether the function Ext is well-defined. We first examine the consequences if h is $\text{Ext}(h, l_i)$.

7.1 Why the Assumption that h is $\text{Ext}(h, l_i)$ is Inadequate

Suppose we assume that the history h that describes (i) is the consistent extension of h at l_i . Then the resulting interpretation of "consistent extension" does not result in a definition of the progressive that squares with intuitions. It will be shown that this follows from the fact that for *any* history h' that, like h , contains facts (1a) and (5a) for $l_i < l_j$, it is *not* possible to maintain the supposition that h' is the consistent extension of h at l_i .

I now argue for this conclusion by considering such a history h' ; it will be shown that h' cannot be the consistent extension of h at l_i . Suppose that h' contains the fact that Max is running in a race at location l , and suppose that he falls over at l_j . Then since Max is lying flat on his face on the track, according to intuitions, (5a), which represents (5), is contained in h' . Suppose that before he fell over, he was winning the race. i.e. (1a) is contained in h' . Then h' at l_i is exactly like the history h at l_i . So h' is an extension of the state of affairs defined by h at l_i (since it is a *superset* of this state of affairs). But is h' the *consistent* extension of h at l_i ?

According to intuitions, *anything* that happens after l_j in the history h' is consistent with Max winning the race at l_i where $l_i < l_j$, because the progressive action is interrupted at l_j since Max falls over at l_j . In particular, Max need not win the race in h' . However, if h' is the consistent extension of h at l_i , then by the semantics of the progressive auxiliary "be", the truth of (1) *requires* Max to win the race in h' . This is contrary to intuitions, and therefore one cannot assume that h' is the consistent extension of h at l_i .

The history h' described here is like the history h that is depicted in (i) above, in that both h' and h contain the facts (1a) and (5a) where $l_i < l_j$. So the argument that h' cannot be the consistent extension of h at l_i equally well applies to h . So h cannot be the consistent extension of h at l_i .

What are the consequences of this?

7.2 Circularity

Given that the realised history h that is depicted in (i) cannot be $\text{Ext}(h, l_i)$, I will now show that the function Ext is *not well-defined*. Furthermore, if one were to try to modify the function Ext in order to make it well-defined, then one would reduce the analysis of the progressive to *circularity*.

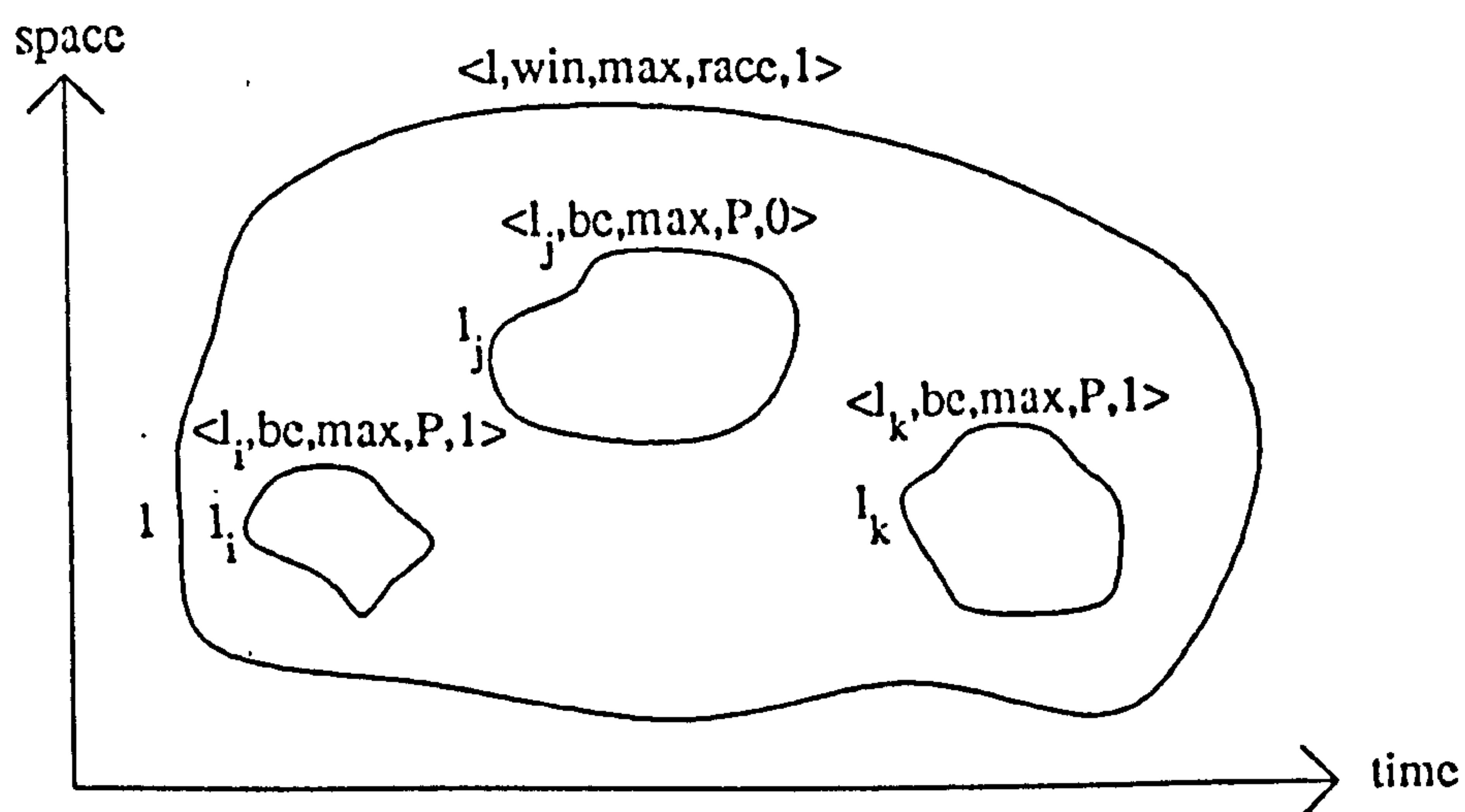
Suppose that the realised history h is as described above (and so is depicted by (i)). Let the fact (7a) represent (7) (so Q represents the verb phrase "draw a circle").

- (7) John is drawing a circle
- (7a) $\langle l_i, \text{be}, \text{John}, Q, 1 \rangle$

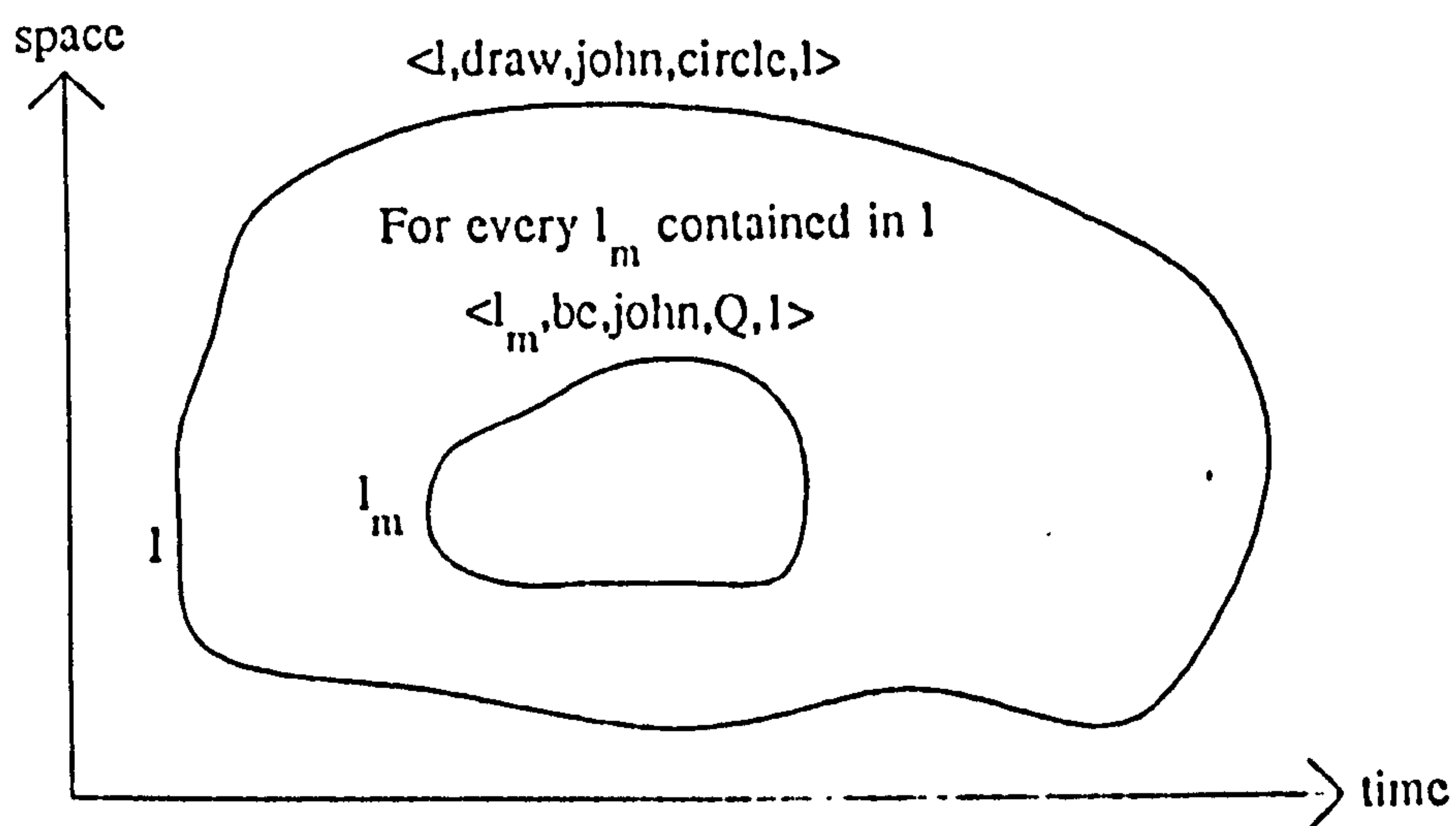
In addition to facts (1a), (5a), (1b) and (4a) being contained in h , suppose that (7b) is contained in h for every location l_m contained in l (i.e. John is drawing a circle at every location l_m contained in l), and the fact (8a), which represents (8), is contained in h (so John draws a circle at location l). (Note that since (7b) is contained in h for every location l_m contained in l , (7a) is contained in h because l_i is contained in l).

- (7b) $\langle l_m, \text{be}, \text{John}, Q, 1 \rangle$
- (8) John draws a circle
- (8a) $\langle l, \text{draw}, \text{John}, \text{circle}, 1 \rangle$

So h describes location structures (i) *and* (ii) below.



(i)



(ii)

The history h is one where John's drawing a circle continues uninterrupted from the location l_i to the location where the target is reached. This is just the course of events that $\text{Ext}(h, l_i)$ is supposed to characterise in the semantics of (7). Therefore to gain the right semantics for (7), this history h must be $\text{Ext}(h, l_i)$ in the semantic interpretation of (7a).

One can now see a problem in defining the function Ext . By our argument in the previous section, the history h depicted by (i) and (ii) above is *not* the consistent extension of h at l_i in the semantic interpretation of (1a), and yet this history h is the consistent extension of h at l_i in the

semantic interpretation of (7a). Therefore we have a situation here where h is $\text{Ext}(h, l_i)$ and h is not $\text{Ext}(h, l_i)$. Hence the two-place function Ext that takes a history and a location as its arguments is *not well-defined*.

How may one modify the function Ext , in order to make it well-defined? If Ext is to be well-defined, then it must be defined relative to *facts*, as well as the history h and location l_i , so that Ext can distinguish that h (that describes (i) and (ii) above) *is* the consistent extension of h at l_i in the semantic evaluation of (7), but *not* of (1). But which facts are appropriate as input to Ext ?

(7) requires h to be the consistent extension of h at l_i because we have assumed that h contains the fact (7b) ("John is drawing a circle") for every location l_m contained in l . (1) requires h *not* to be the consistent extension of h at l_i because we have assumed that h contains the fact (5a) ("It is not the case that Max is winning the race") at a location l_j contained in l (cf. section 7.1). Therefore, in order for Ext to predict that h is the consistent extension of h at l_i in the semantic evaluation of (7) but h is not the consistent extension of h at l_i in the semantic evaluation of (1), Ext must be defined relative to the progressive facts at locations contained in l . That is, Ext must be a function whose arguments in the semantic evaluation of (1a) are l_i , h and $\langle l_j, \text{be}, \text{max}, P, 0 \rangle$ ²⁸.

One now has the following problem in specifying Ext . In order to obtain a satisfactory specification of the function Ext , it must include as arguments the progressive facts. But the progressive is defined in terms of Ext , and so to introduce progressive facts as an argument to Ext would reduce the analysis to *circularity*. This is exactly analogous to the snag encountered in Dowty's theory. Under the assumption that (i) defines a possible state of affairs, the function Inr is not well-defined, and if one were to modify it to make it well-defined, then the analysis of the progressive would be reduced to circularity.

The function Ext is crucial to defining the progressive in terms of eventual outcome in Cooper's theory. But under the assumption that the history h that depicts (i) can be realised, the function Ext cannot be specified. Therefore, to preserve the Eventual Outcome Strategy, one must place conditions on the semantics of (4) or the semantics of the progressive to ensure that h *cannot be realised*.

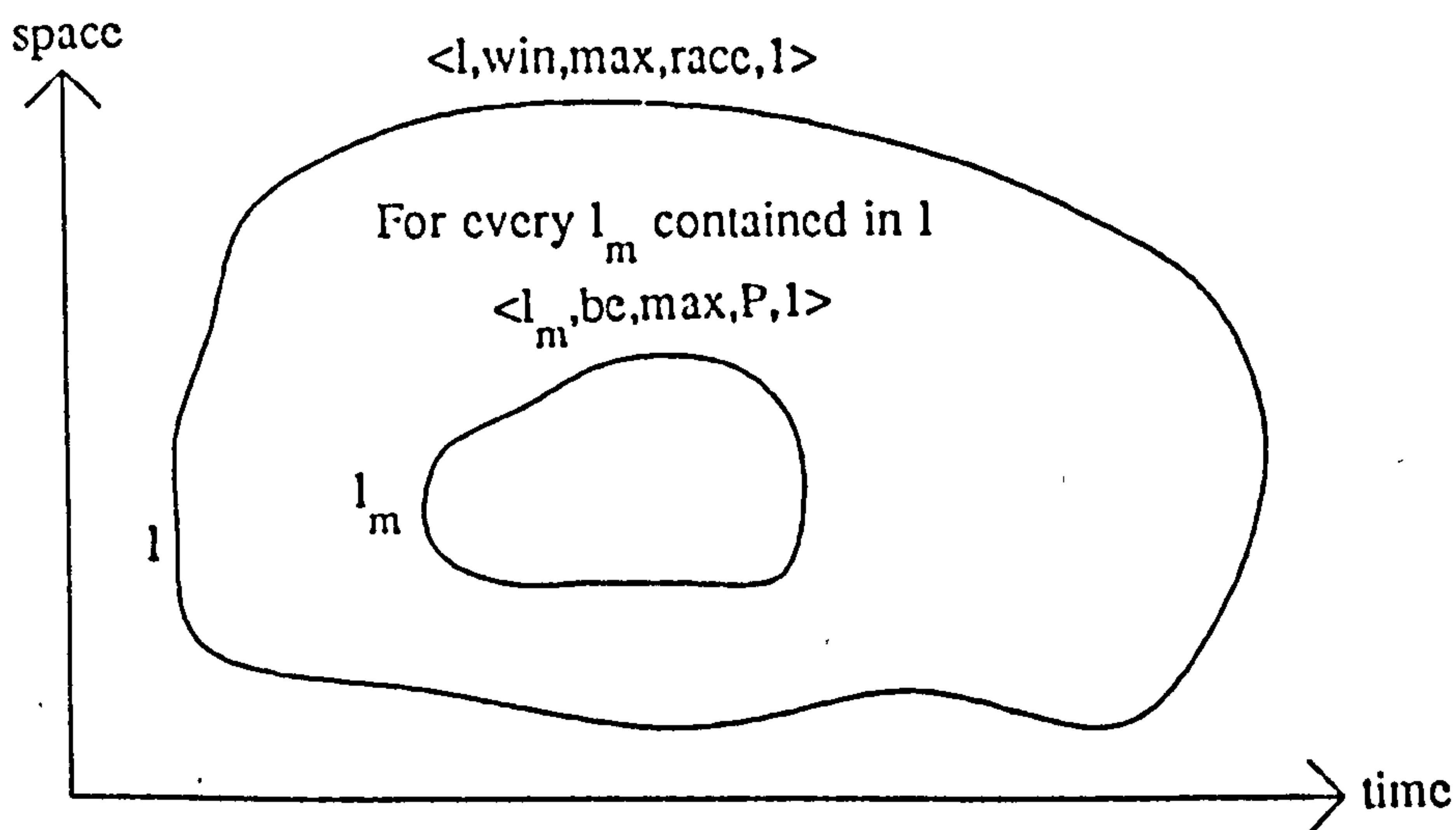
(4) Max wins the race

²⁸ Notice that it is the *progressive* facts that must be input to Ext , because the non-progressive facts agree in semantic value with respect to h .

In other words, the semantics of (4) and the semantics of the progressive must ensure that any realised history h that contains the fact (4a) (representing (4)) must also contain the facts (1b) (representing (1)) for *every* location l_m contained in l .

- (4) Max wins the race
- (4a) $\langle l, \text{win}, \text{max}, \text{race}, l \rangle$
- (1) Max is winning the race
- (1b) $\langle l_m, \text{bc}, \text{max}, P, l \rangle$

This history is depicted in (iii) below.



(iii)

8 How to Ensure that (i) is Inconsistent

How may one guarantee that if a realised history h contains the fact (4a), then it also contains the facts (1b) for *every* location l_m contained in l ? I will argue that this temporal structure cannot be derived from Cooper's current semantic interpretation of (4a). Furthermore, it cannot be derived by revising Cooper's semantic interpretation of (4a) without undermining the Eventual Outcome Strategy.

8.1 The Current Interpretation of Temporal Groundedness

Suppose one fixes Cooper's semantics for the sentence (4) (i.e. one preserves *Temporal Groundedness*), and suppose that the function Ext is defined so that if the realised history h contains the fact (4a) then it contains the facts (1b) for every location l_m contained in l . Then although placing conditions on Ext to guarantee this structure is technically viable, it is materially inadequate, given the current semantics for (4). To show this, I will construct a realised history h'' where the truth of (1) is contrary to its actual use.

Consider the history h'' where Max is born at location l_i (i.e. h contains the fact $\langle l_i, \text{born}, \text{max}, l \rangle$), and Max wins the race at location l (i.e. h'' contains the fact (4a)), where l spans twenty years and contains l_i . According to Temporal Groundedness this history can be realised, for we have *not* assumed that the history contains a fact (4b), where l_m is contained in l .

(4b) $\langle l_m, \text{win}, \text{max}, \text{race}, l \rangle$

Indeed, Cooper offers *nothing* in the semantics of (4) to bar Max from being born at a location contained in one where he wins the race. Thus if one specifies consistency so that h'' contains (1b) for all locations l_m contained in l , then (1) is true at l_i , the location where Max is born. This is contrary to its actual use. The discrepancy between the truth value of the progressive and its actual use arises from the fact that *Temporal Groundedness* does not yield an interpretation of (4) as a process that leads to a goal. Hence the required relationship between (1) and (4), i.e. that (i) is inconsistent, cannot be obtained with Temporal Groundedness.

This corresponds to the problem that we found with Dowty. Dowty cannot account for (i) as inconsistent given his current truth conditions for BECOME, because BECOME does *not* yield an interpretation of (4) as a process that leads to a goal.

One cannot explain in Cooper's theory that the history h describing (i) cannot be realised, given his current analysis of (4). The question now is: how can the semantics of (4) be modified?

8.2 A Change to Temporal Groundedness

How may one modify Cooper's structural constraints on (4) to ensure that if (4a) (representing (4)) is contained in a realised history h , then (1b) (representing (1)) is contained in h for every location l_m contained in l , in such way that the analysis of the progressive agrees with its actual use?

- (1) Max is winning the race
- (1b) $\langle l_m, \text{win}, \text{max}, \text{race}, 1 \rangle$
- (4) Max wins the race
- (4a) $\langle 1, \text{win}, \text{max}, \text{race}, 1 \rangle$

If the analysis of (1) is to agree with intuitions, then the structural constraints on (4a) must ensure that the states of affairs at locations *contained* in 1 are ones where we would naturally assert (1) as true, e.g. Max is ahead in the race, or he is third but running faster than the athletes in first and second place, etc. In other words, the semantics of (4a) must assert that all the locations contained in 1 are ones where the process that leads to the target is going on. In order to achieve this analysis, the semantics of (4a) must *characterise* the process that leads to the target.

The Eventual Outcome Strategy is an attempt to characterise the process that leads to the target in terms of eventual outcome. Can one characterise the process in terms of eventual outcome within the semantic analysis of (4a)? The definition of the process in terms of eventual outcome that Cooper offers is given in the semantics of the progressive auxiliary "be" with the use of *consistent extensions*, and this semantic definition is given in terms of (4a). So one cannot use this to define (4a), or the analysis would be reduced to circularity. Instead, the semantics of (4a) must characterise the process that leads to the target by placing conditions *directly* on what the process consists of; i.e. it must assert that the process goes on only if Max is ahead, or he is third but running faster than the athletes in first and second place, etc.

This goes against the grain of the Eventual Outcome Strategy. The aim is to characterise the process purely in terms of *eventual outcome*. There must be *no* conditions placed *directly* on what the process consists of. Therefore, one undermines the Eventual Outcome Strategy if the semantics of (4) characterises the process by placing conditions directly on what the process consists of. But we have argued that having such a semantics for (4) is the only way we can explain that the history *h* that describes (i) cannot be realised. Hence one cannot modify Cooper's semantics for (4) to ensure that *h* that describes (i) cannot be realised without undermining the Eventual Outcome Strategy.

Just as with Dowty's, Cooper's semantic analysis of (4) cannot ensure that the situation depicted in (i) is *inconsistent*. Furthermore, one cannot revise his analysis of (4) to make (i) inconsistent without undermining the Eventual Outcome Strategy. Therefore, the history *h* that depicts (i) must be consistent.

But this is in conflict with the argument given in section 7, that in order to give a satisfactory specification of the function *Ext*, the history *h* that depicts (i) must *not* ever be realised. The semantics of (4) and the specification of *Ext* are both essential ingredients to Cooper's formulation of the Eventual Outcome Strategy. But the semantics of (4) requires (i) to be consistent and the specification of *Ext* requires (i) to be inconsistent. Therefore, just like Dowty's, Cooper's formulation of the Eventual Outcome Strategy fails.

9 Hinrichs' Formulation of the Eventual Outcome Strategy

Hinrichs' formulation of the Eventual Outcome Strategy is in the framework of *situation semantics*, but a different version to that of Cooper's. I will now review the terminology that he makes use of.

9.1 The Backdrop

Hinrichs' framework is the version of situation semantics in (Barwise and Perry 1983). The basic construct is a *situation-type*, which in this version is a partial function from *n*-ary relations and *n* individuals to truth values. For example, the situation-type in which Molly barks and Jackie doesn't is *s*.

s := barks, Molly; yes
 barks, Jackie; no

This is slightly different from Cooper's interpretation of a situation-type, as a set of fact-types.

From situation-types, one can construct *courses of events*. A course of events is a partial function from locations to situation-types. For example, the course of events in which Molly barks, and then Mr. Levine shouts at Molly, and then Molly stops barking is denoted by σ below:

σ := at *l*: barks, Molly; yes
 at *l'*: shouts-at-, Mr. Levine, Molly; yes
 at *l''*: barks, Molly; no
 where *l*, *l'* and *l''* are locations and $l < l' < l''$

A course of events that is defined on one location alone is a *state of affairs*. Among all possible courses of events, there is a designated course of events σ^* which is *actual*.

One can also construct *event-types* in this framework. An event-type is exactly like a course of events, save that one or more of the *indeterminates* may appear in place of genuine individuals, relations or locations. Event-types are used to express complex properties. For example, the complex property of being a tired hungry philosopher is described in the event-type E below:

E:= at l: philosopher,a;yes
 tired,a;yes
 hungry,a;yes

One can introduce *anchors* for event-types. An anchor for an event-type E is a function f assigning individuals, relations and locations to some of the indeterminates in E. Given an anchor f of E, one can construct a new event-type E[f] by replacing each indeterminate x in the domain of f by its value f(x). A total anchor is a function f whose domain includes all the indeterminates in E.

Given the anchors on event-types, one can relate *events* to corresponding *event-types*. A course of events e *is of type* E if E[f] is part of e for some anchor f (f is necessarily total). I presume that a partial function E[f] is *part of* a partial function e if the domain of E[f], written dom(E[f]) (this is a set of locations), is contained in dom(e) (also a set of locations) and for all l in dom(E[f]), E[f](l) = e(l).

9.2 Hinrichs' Analysis of the Progressive

Hinrichs' definition of the progressive is an attempt to improve on Dowty's analysis by replacing the primitive construct *inertia worlds* with an independently motivated construct in situation semantics; *structural constraints*. But what are structural constraints in Hinrichs' version of situation semantics?

9.2.1 Structural Constraints

Structural constraints provide one with information on how the world is made up. The actual course of events must comply with structural constraints. There are three types; *necessary* constraints, *nomic* constraints, and *conventional* constraints. Necessary constraints are ones that arise from necessary relations, for example the constraint that every woman is human. Nomic constraints are inviolable patterns in nature, for example the constraint that a ball once thrown must eventually come down.

Conventional constraints are ones that arise from conventions that hold within a community of living beings, for example the relation between the ringing of the bell and the end of class. In contrast with the other two types of constraints these are *violable*; that is, the actual course of events need not necessarily comply with conventional constraints. To know English one must know the meaning of basic *lexical items*. This is all knowledge about various conventional constraints.

Barwise and Perry (1983) represent structural constraints by invoking the primitive relation *involves* that holds between event-types. *Unconditional* structural constraints, (the only type we consider here), are all of the form given below, where l_u denotes the universal location:

$C := \text{at } l_u : \text{involves}, E, E'; \text{yes}$

As an example of a constraint, Barwise and Perry sight CO below, which is supposed to assert that kissing involves touching.

$CO := \begin{array}{ll} \text{at } l_u : \text{involves}, E, E'; \text{yes} \\ E := \text{at } l : & \text{kisses}, a, b; \text{yes} \\ E' := \text{at } l : & \text{touches}, a, b; \text{yes} \end{array}$

Given the constraint C,

$C := \text{at } l_u : \text{involves}, E, E'; \text{yes}$

Barwise and Perry introduce the following terminology that we will subsequently make use of:

- (i) A course of events e is *meaningful* with respect to C if e is of type E . For example, the course of events e given below is meaningful with respect to the constraint CO above, since e is of type E .

$e := \text{at } l : \text{kiss}, \text{max}, \text{mary}; \text{yes}$

- (ii) If e is meaningful with respect to C , then e' is a *meaningful option* from e with respect to C if for every total anchor f for exactly the indeterminates in E , if e is of type $E[f]$, then e' is of type $E'[f]$. For example, e' , defined below, is a meaningful option from e with respect to CO, where e and CO are as defined above.

$e' := \text{at } l : \text{touch}, \text{max}, \text{mary}; \text{yes}$

Hinrichs uses structural constraints to define the progressive. However, it is not very clear what a constraint is, since Barwise and Perry are not very clear on which event-types E stand in the primitive relation *involves* to which event-types E' . Because of this, when we review Hinrichs' definition of the progressive, we will have to ask ourselves what the relation *involves* would have to look like in order that Hinrichs' definition of the progressive agrees with its actual use.

9.2.2 How Hinrichs Uses Structural Constraints

To motivate how structural constraints contribute to the semantics of the progressive, consider sentence (9).

(9) Max is making a bid

Hinrichs claims that (9) will count as true in a course of events characterised in (10) because there is a conventional constraint to the effect that raising one's hand at an auction constitutes making a bid.

(10) $\sigma =$ at l :
 auction, a ; yes
 raising-his-hand, max; yes
 be-at, max, a ; yes
 intend, max, (bid, max); yes

Hinrichs' definition for the progressive with respect to a course of events σ at location l , written as σ_l , is (11).

(11) $\sigma_l(\text{PROG}(R_n), a_1, \dots, a_n) = 1$ if and only if
 there is a course of events σ' contained in or equal to σ^* such that:
 (i) $\neg(\exists l')(l' \in \text{dom}(\sigma') \ \& \ l' > l) \ \& \ l \in \text{dom}(\sigma')$
 (ii) there is a structural constraint
 C_n : at l_u : involves, E, E' ; yes
 such that σ' is meaningful with respect to C_n and σ'' is a meaningful option from σ' with respect to C_n , and $\sigma''_{l''}(\text{PROG}(R_n), a_1, \dots, a_n) = 1$ for l contained in l'' .

Before we discuss the ideas behind this definition, we should note that it features a glaring peculiarity; there are no conditions placed on the course of events σ with respect to which the progressive sentence is evaluated. So sentence (1) (whose representation is (1a)) is either true with respect to *every* course of events (whether or not they are actual) or it is false with respect to *every* course of events; i.e. (1) is an eternal sentence.

- (1) Max is winning the race
 (1a) (PROG(win),max,race)

To overcome this, one may revise (11) to (11a):

- (11a) $\sigma_1(\text{PROG}(R_n), a_1, \dots, a_n) = 1$ if and only if
 σ is contained in σ^* and
 (i) $\neg(\exists l')(l' \in \text{dom}(\sigma) \ \& \ l' > l) \ \& \ l \in \text{dom}(\sigma)$
 (ii) There is a structural constraint
 $C_n := \text{at } l_u : \text{involves}, E, E'; \text{yes}$
 such that σ is meaningful with respect to C_n and σ'' is a meaningful option from
 σ with respect to C_n , and
 $\sigma''_{l'}(R_n, a_1, \dots, a_n) = 1$ for l contained in l''

(11a) is exactly the same as (11) save that the truth conditions that were placed on the course of events σ' in definition (11) are now placed on the course of events σ of evaluation. This guarantees that (1) will be true with respect to some courses of events σ (and these courses of events must be actual) and false with respect to others; i.e. (1) is no longer an eternal sentence. Since (11a) improves on the analysis of the progressive in this respect, I will adopt definition (11a) from now on²⁹.

Let us discuss the semantic role played by clauses (i) and (ii) in the definition (11a). Clause (i) allows σ to contain any facts up to the point of speech and therefore ranges in effect over the entire context of an utterance. Clause (ii) in (11a) gives Hinrichs' definition of the progressive its "eventual outcome" properties. For example, the *conventional completion* as described by (conventional) structural constraints of the state of affairs σ at location l that makes (1) true is the state of affairs σ' at location l' that makes sentence (4), whose representation is (4a), true where l' contains l .

- (4) Max wins the race
 (4a) (win,max,race)

So *conventional completion* in Hinrichs' theory corresponds to the course of events 'continuing uninterrupted'.

Hinrichs claims that he explains how (1) can be true even if (4) is never true by the violable nature of structural constraints. An actual course of events σ makes (1) true if it is meaningful with

²⁹ The criticisms that I will eventually give of (11a), however, will equally well apply to (11).

respect to a structural constraint, where the RHS of the constraint is a course of events that, if it were actual, would make (4) true. But if the constraint is violated, then the course of events corresponding to the RHS is not actual and so (4) will not be true.

Hinrichs is using structural constraints where Dowty used inertia worlds and Cooper used consistent extensions: these tell us when the current state of affairs ‘continues uninterrupted’. Hinrichs claims that structural constraints are motivated independently of the semantics of the progressive, whereas inertia worlds and consistent extensions are not. However, it is not clear that this is the case. Indeed, until we have some idea of which event-types E stand in the primitive relation *involves* to which event-types E' , we do not even know what the constraints are. Therefore, given the particular event-types E and E' , we have the task of stating whether E *involves* E' . This task must be carried out with the definition of the progressive in mind. The structural constraints we have as a result of our specification of *involves* must ensure that the definition of the progressive in terms of structural constraints that is given in (11a) squares with its actual use.

10 The Data in Hinrichs’ Theory

We have the task of stating which event-types E stand in the primitive relation *involves* to which event-types E' . In order to see what requirements must be placed on the relation *involves* so that Hinrichs’ definition of the progressive agrees with intuitions, I will investigate the truth conditions of a particular example, namely sentence (1).

(1) Max is winning the race

Suppose that Max is running in a race of four laps, and suppose that at the start of the third lap he is ahead in the race and running the fastest. Then according to intuitions, sentence (1) is true. Let l_3 be the location that refers to the time when Max starts the third lap. Then the course of events where Max is ahead and running the fastest at the start of the third lap corresponds to the course of events σ below:

$\sigma :=$ at l_3 : ahead,max,race;yes
 fastest,max,race;yes

So to capture the intuitions concerning (1) in Hinrichs’ definition of the progressive, (1) must be true with respect to σ at location l_3 . i.e. σ must satisfy conditions (i) and (ii) in (11a). What does this tell us about the relation *involves*?

First by condition (ii), there must be some constraint C such that σ is meaningful with respect to C , and σ' defined below (corresponding to "Max wins the race") must be a meaningful option from σ with respect to C , such that l_3 is contained in l .

$\sigma' :=$ at l : win,max,race;yes

What should the constraint C be?

Let C be as defined below:

$C :=$ at l_u : involves,E,E';yes

What are the event-types E and E' ? For σ to be *meaningful* with respect to C , σ must be of type E . So there must be some anchor f such that $E[f]$ is part of σ ; i.e. the domain of $E[f]$ must be contained in the domain of σ and $E[f]$ must equal σ on that domain. The domain of σ is $\{l_3\}$, and so the domain of $E[f]$ must be the empty set or $\{l_3\}$. Since it makes no sense for the domain of $E[f]$ to be the empty set, the domain of $E[f]$ must be $\{l_3\}$. Now the value of $E[f]$ at l_3 must be the same as that of σ . The value of σ is s given below:

$s :=$ ahead,max,race;yes
 fastest,max,race;yes

So suppose $f(a) = \text{max}$. Then if E is as defined below, then the value of $E[f]$ at l_3 is s , as required.

$E :=$ at l_3 : ahead,a,race;yes
 fastest,a,race;yes

So the event-type E in constraint C must be as we have it defined here.

According to condition (ii) in (11a), the course of events σ' must be a *meaningful option* from σ with respect to C . Therefore, σ' must be of type $E'[f]$ (i.e. $E'[f]$ must be part of σ'), where $f(a) = \text{max}$. So E' must be as defined below:

$E' :=$ at l : win,a,race;yes

We have seen which event-types C must relate with the relation *involves*, but there still remains something to be said about the relation between the location l_3 (featured in E) and l

(featured in E'). For (1) to be true with respect to σ at location l_3 , by condition (ii) in (11a) l must contain l_3 , which is the time corresponding to when Max starts the third lap. Furthermore, since l corresponds to the location where Max wins the race, it must contain the time when the target, i.e. Max crosses the finish line in first place, is reached. Since the race is four laps long, this means that l must contain the time when Max finishes the fourth lap. Assuming that l is connected, l must contain the time spanning from when Max starts the third lap to when he finishes the fourth lap.

Given the requirements on the event-types E and E' and the locations l_3 and l that we have discussed, the constraint C must be as defined below.

C:= at l_u : involves, E, E'; yes
 E:= at l_3 : ahead, a, race; yes
 fastest, a, race; yes
 E':= at l: win, a, race; yes
 where l_3 is contained in l.
 (l_3 corresponds to the time when a starts the third lap and l corresponds to the time spanning from when a starts the third lap to when he finishes the fourth and final lap).

So, in order for (11a) to agree with the intuition that (1) is true with respect to the course of events σ at location l_3 , the structural constraint C above must exist; the event-types E and E' defined above must be related by the relation *involves*.

We now have the following problem on our hands. Suppose that at the start of the third lap Max is ahead in the race and running the fastest. Furthermore, suppose that at the start of the fourth lap, Max has fallen back and he is now last and the slowest. This corresponds to the course of events σ'' below, where l_4 corresponds to the time when Max starts the fourth lap.

$$\begin{array}{ll} \sigma' := & \text{at } l_3: \quad \text{ahead,max,race;yes} \\ & \quad \quad \text{fastest,max,race;yes} \\ & \text{at } l_4: \quad \text{last,max,race;yes} \\ & \quad \quad \text{slowest,max,race;yes} \\ & l_3 < l_4 \end{array}$$

Then one can show that according to (11a), sentence (1) is true with respect to the course of events σ'' at location l_4 , where Max is last in the race and running the slowest, contrary to intuitions.

Let us evaluate the truth value of (1) with respect to the course of events σ' at location l_4 . First, σ' satisfies condition (i) of (11a) because the domain of σ' contains no locations later than l_4 . To satisfy condition (ii), σ' must be meaningful with respect to some constraint C' , and σ' defined

below must be a meaningful option from σ'' with respect to C' , and l_4 must be contained in l .

$\sigma' :=$ at l : win,max,race;yes

One can show that this condition is satisfied when the constraint is C as defined above.

First, to show that σ'' is meaningful with respect to C : the domain of E (defined in C above) is $\{l_3\}$ and this is contained in the domain of σ'' which is $\{l_3, l_4\}$. Furthermore the value of $E[f]$, where $f(a) = \text{max}$, at the location l_3 is the same as that for σ'' at l_3 . Therefore $E[f]$ is part of σ'' , and so σ'' is of type E . Hence σ'' is *meaningful* with respect to the constraint C . Furthermore, σ' is a *meaningful option* from σ'' with respect to constraint C because σ' is of type $E'[f]$ where $f(a) = \text{max}$. Moreover, the location l_4 is contained in l , for l contains the time when Max starts the fourth lap, which is just l_4 . Hence the course of events σ'' satisfies condition (ii) of the definition (11a). Hence according to (11a), (1) is true with respect to the course of events σ'' at location l_4 . But this corresponds to Max being last in the race and running the slowest, and so according to intuitions, (1) is false with respect to this situation. Hence the current definition of the progressive given in (11a) does not agree with its actual use.

How can one improve on the problematic analysis of (1)? As we have discussed, Hinrichs is using constraints in the definition of the progressive to define when the process 'continues uninterrupted'. So using the constraint C in defining (1) is supposed to capture the idea that the process 'continues uninterrupted'. The problem with the current analysis of (1) is that the constraint C does not assert *anything* about what happens between the start of the third lap and the finish line. It therefore cannot capture in the way that we desire the notion that the process going on at the start of the third lap (that Max is ahead and running the fastest) 'continues uninterrupted'. To improve on Hinrichs' problematic analysis of (1), we must overcome this flaw. We must *replace* the constraint C with some other constraint that better captures our intuitions about when the process 'continues uninterrupted'. How is this to be done?

In order to capture in structural constraints the notion of a process 'continuing uninterrupted' in the way we desire, we might *replace* the constraint C with a constraint C_1 defined as below, which asserts that the individual *remains* ahead in the race and runs the fastest from the start of the third lap right up to the time he crosses the finish line.

$C_1 :=$ at l_u : involves, E_1, E'_1 ; yes
 $E_1 :=$ at l : ahead, a, race; yes
fastest, a, race; yes

$E'_1 :=$ at l : win,a,race;yes

where l spans the time from the beginning of the third lap to when Max crosses the finish line.

Unlike C , the constraint C_1 captures the idea that the process continues uninterrupted, because C_1 requires Max to *remain* ahead in the race and *remain* the fastest. By getting rid of the constraint C and replacing it with the constraint C_1 , we guarantee that (1) is *false* with respect to the course of events σ' at l_4 , as desired, for σ' is not meaningful with respect to C_1 and so σ' does not satisfy condition (ii) of definition (11a). Hence we seem to have improved the analysis of (1).

However, there are two problems in getting rid of the constraint C and replacing it with the constraint C_1 . First of all, the course of events σ where Max is ahead and running the fastest at the beginning of the third lap is *not* of type E_1 , for the domain of E_1 is $\{l\}$ and the domain of σ is $\{l_3\}$ and so the domain of E_1 is not contained in the domain of σ .

$\sigma :=$ at l_3 : ahead,max,race;yes
fastest,max,race;yes

Therefore, σ is not meaningful with respect to C_1 , and so σ does *not* satisfy condition (ii) in definition (11a) (since we have got rid of C and *replaced* it with C_1 and so there is now no constraint with respect to which σ is meaningful and σ' is a meaningful option). Therefore (1) is predicted to be false with respect to the course of events σ , contrary to intuitions.

The second problem in replacing the constraint C with the constraint C_1 is that defining the constraint C_1 amounts to defining *directly* what the process that leads to the goal consists of (C_1 says the process consists of Max being ahead and running the fastest). The Eventual Outcome Strategy is an attempt to define the process in terms of *eventual outcome* instead of defining it directly. Therefore, in replacing the constraint C with the constraint C_1 , we have undermined Hinrichs' formulation of the Eventual Outcome Strategy.

Hinrichs attempts to define when the state of affairs continues uninterrupted in terms of constraints. We have argued that in doing this, he fails to capture the natural language data. Furthermore, we found that the constraints must define *directly* what the process that leads to the goal consists of. But the Eventual Outcome Strategy attempts to define the process purely in terms of eventual outcome instead of directly, and so, like Dowty and Cooper, Hinrichs' formulation of the Eventual Outcome Strategy fails.

11 Conclusion

In characterising the semantics of (1), one might adopt what I have called the *Eventual Outcome Strategy* for defining the progressive.

(1) Max is winning the race

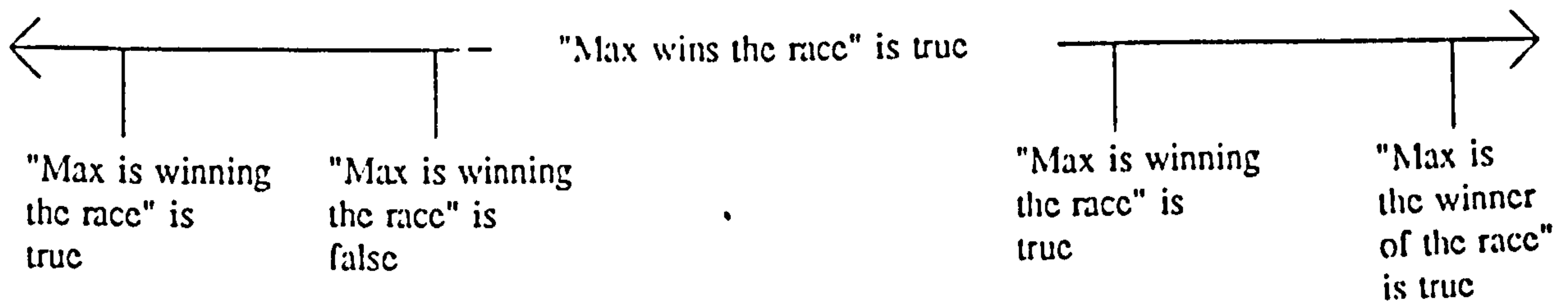
The intuition behind the strategy is the following: (1) is true if *whatever* the current state of affairs is, if that state of affairs were to continue uninterrupted, then the *eventual outcome* would be that Max is the winner of the race. The idea is that the conditions defined by the semantics of the progressive should not concern what is going on now, but must concern only the eventual outcome of what is going on now. To achieve this the process that (1) refers to is characterised purely in terms of the culmination, plus some appropriate notion of *modality*, where the modality explains the phrase "if the process were to continue uninterrupted". The Eventual Outcome Strategy thus avoids placing conditions *directly* on what the process consists of. For example in the semantics of (1), one avoids talk about Max's position in the race, how fast he is running, etc.

In this chapter, I have investigated whether the Eventual Outcome Strategy could be formulated. There have been three attempts to formulate the strategy, (Dowty 1979), (Cooper 1985) and (Hinrichs 1983). Hinrichs' formulation of the strategy proved problematic. In order to explain the phrase "if the process were to continue uninterrupted", it was necessary in Hinrichs' theory to define *directly* what the process consists of. But if one does this, then one is no longer adopting the Eventual Outcome Strategy, where the aim is to define the process in terms of eventual outcome rather than directly.

With respect to Dowty's and Cooper's theories, I asked the following question: Given that (4) is true at a period K,

(4) Max wins the race

is it consistent that (1) is true and then false and then true at times contained in K? i.e. is (i) a consistent state of affairs?



(i)

We have seen that an Eventual Outcome semantics of the progressive defines (1) purely in terms of the culmination, plus some appropriate notion of modality. I argued that in order to define the appropriate notion of modality in Dowty's and Cooper's theories, one must insist that (i) is inconsistent. On the other hand, I argued that in order to define (1) *purely* in terms of the *culmination*, one must allow (i) to be consistent. This exposed a tension between the two tasks that must be tackled in formulating the Eventual Outcome Strategy; defining the appropriate notion of modality and defining (1) purely in terms of the culmination. Hence the Eventual Outcome Strategy is undermined.

One is now left with a puzzle. There is a wealth of states of affairs that make sentence (1) true. (1) may be true when Max is ahead, in second place or last at the current time.

(1) Max is winning the race

In this chapter, I have investigated whether one may canvass in the formal semantic analysis of the progressive the intuition that the common property among these states of affairs is one of eventual outcome, the eventual outcome being the one described by "Max wins the race". This intuition is not sufficient to yield a satisfactory logical analysis of the progressive however. The puzzle is: how else may the progressive be defined so as to lead to a solution to the imperfective paradox? In the next chapter, we will assess an alternative strategy, that I call the *Event-based Strategy*, for defining the progressive.

Chapter 4

The Progressive in an Event Ontology

1 Introduction

To see an alternative perspective on the characterisation of the progressive, let us see what relation we intuitively feel holds between sentences (1) and (2).

- (1) Max was winning the race
- (2) Max won the race

Intuitively, sentence (2) refers to an event that can be divided into phases; it is a *process* which leads to a *culmination*. (1) refers to that process, but it does not assert that the culmination occurred.

This is the intuition underlying what I call the *Event-Based Strategy* in defining the progressive. The object of this chapter is to test this strategy. Event-based theories of tense and aspect construct *event ontologies* to take into account the internal structure of events (Bach 1986, Moens 1987, Parsons 1984, ter Meulen 1982, 1984). According to event ontologists, sentences like (2) refer to events that are divided in the event ontology into constituent parts: a process and a culmination point. The *eventual outcome* of the process, provided it continues uninterrupted, is the culmination point. This structure arises from the way the ontology for events is set up.

Unlike the Eventual Outcome Strategy, the concept of a prior process (that is, the process that leads to a culmination) is *not* brought out purely by a *modal semantics* for the progressive. Instead, there are more ontological commitments: culmination points are assigned definite prior processes in the ontology. Hence constructing an event ontology provides a natural alternative to the Eventual Outcome approach. The concept of eventual outcome that is defined *explicitly* in the *semantic* definition of the progressive under the Eventual Outcome Strategy now appears as part of the event ontology; i.e. it is now one of the idiosyncratic things that is given as part of the model, rather than being defined in terms of rules. The event ontology thus provides the potential means to achieve one of the tasks connected with the imperfective paradox: defining the progressive. The event-based semantics of (1) will refer to the process that is assigned in the event ontology to (2)'s culmination.

Moreover, the Event-based Strategy provides a way of accomplishing the other task connected with the imperfective paradox: distinguishing the semantics of sentences like (2) and (3).

(3) Max ran

The distinct semantics of (2) and (3) can be explained by assigning the underlying events different structures in the ontology.

So, following the Event-based Strategy may prove fruitful for solving the imperfective paradox, since it provides a way of fulfilling both of the tasks connected with the problem: distinguishing the semantics of (3) and (2) and providing a semantic definition of the progressive. The object of this chapter is to evaluate how the Event-based approach tackles these two tasks in solving the imperfective paradox. I start by discussing briefly Bach's (1986) theory, and then I will study Parsons' (1984) theory in detail, in order to assess the viability of the Event-based Strategy.

2 Bach's Lattice-Theoretic Approach

Bach (1986) applies Link's (1983) lattice theory to the domain of event descriptions. Bach's aim is to allow events to be *decomposed* in the ontology into the stuff in D from which they are made, and to allow for the *composition* of events into more complex ones.

Bach's event ontology constitutes a domain E of *events*, a domain A contained in E of *atomic events*, and a domain D contained in A of *stuff* from which events are made. Atomic events are events such as "Max builds a house" and "Max wins a race". By means of a join operation \cup_E , the domain A is extended into E, so that E contains plural events, such as "Max builds a house and Max wins a race". The domain E is closed under the join operation \cup_E , and there is a partial ordering \leq_E on E satisfying condition (4).

(4) for all $e_1, e_2 \in E$, $e_1 \leq_E e_2$ if and only if $e_1 \cup_E e_2 = e_2$

D is also closed under its join operation \cup_D .

Processes are considered to be the stuff that constitutes events. There is a homomorphism h from the domain E to D which relates events in E to the stuff from which they are made. The homomorphism h satisfies the following conditions:

h: E \rightarrow D is a homomorphism such that
 (i) For all $d \in D$, $h(d) = d$

- (ii) For all $e_1, e_2 \in E$, $h(e_1 \cup_E e_2) = h(e_1) \cup_D h(e_2)$
- (iii) For all $e_1, e_2 \in E$, if $e_1 \leq_E e_2$, then $h(e_1) \leq_D h(e_2)$

Bach argues that the progressive form of a sentence denoting an event is derived from the stuff from which that event is made. Hence the progressive is a function of the homomorphism h . For example, sentence (5) is true if certain processes occur which form part of the event described by sentence (6).

- (5) Max is building a house
- (6) Max builds a house

Bach claims that the imperfective paradox is solved since processes that form part of an event may occur without the event itself occurring. However, Bach does not say how a definition of the homomorphism h might contribute to such a solution. It is difficult to assess the viability of Bach's approach, because he does not show how the homomorphism h blocks the entailment between (5) and (6). Indeed, he does not even state the logical forms of these sentences, and so one cannot see how they are related at all. Bach's lattice-theoretic approach may lead to a solution to the imperfective paradox, but so far, one has not been developed. We therefore just note it in passing.

Parsons (1984) event-based theory offers a formal solution to the imperfective paradox, and so we will study Parsons' theory in detail, in order to assess the Event-based Approach.

3 Parsons' Ontology

Parsons' (1984) account of the semantics of a fragment of English presupposes that in addition to individuals and times in the ontology, there are *events*, corresponding to Vendler's accomplishments and achievements, *processes*, corresponding to Vendler's activities, and *states*, corresponding to Vendler's states (Vendler 1967). For example, (7) reports a state, (3) a process and (8) an event.

- (7) Max is a doctor
- (3) Max ran
- (8) Max made a sandwich

Events, processes and states are grouped together in the theory under *eventualities*. Eventualities usually have *agents* and may also have *objects*. For example, if Max builds a house, then there is a building event of which Max is the agent and the house is the object.

The three classes of eventualities are ontologically interpreted in different ways. In the case of *events*, one can typically identify subparts; a *development portion* and a *culmination*. For example, if Max builds a house, then there is a period of time during which the building is going on - the development portion - and then (if he finishes) a time at which the house finally gets built, the time of culmination. I will show, however, that Parsons doesn't use the distinction between the development portion of an event and its culmination in the *logical* formalism. Nevertheless, the distinction remains a useful one to draw, in order to understand the intuitions underlying the ontology of eventualities. So it will remain useful to bear in mind the distinction between development portions and culminations.

The ontological interpretation of events is in sharp contrast to that of *processes* and *states*. Events may culminate, but processes and states cannot ever culminate. Processes merely *go on* at a time *t*, and states *hold* ³⁰.

4 The Formalism

Parsons attempts to reflect some of the ontological intuitions concerning eventualities in the semantic component of the theory. The symbolism is as follows: *e* and *e'* are used as variables that range over eventualities. The predicate *Cul(e,t)* is used to mean that *e* is an event which culminates at time *t*. The predicate *Hold(e,t)* means that the eventuality *e* holds at *t*. This can be interpreted in one of three ways: either (i) *e* is a state and *e*'s agent is in state *e* at time *t*, or (ii) *e* is a process that is going on at *t*, or (iii) *e* is an event which is in development at *t*.

Parsons gives the syntax and logical forms of a small fragment of English in a format that is similar in style to Montague grammar. The syntactic categories that are used are NAME ("Proper Noun"), VERB ("Verb"), VP ("Verb phrase or "Predicate"), CL ("Sentential clause"), and S ("Sentence"). The logical symbolism is essentially a three-sorted version of the ordinary predicate calculus with predicate abstraction. Corresponding to each of the three 'sorts' is a style of variable. *x*, *y*, *z*...are variables that range over individuals; *t*, *t'*...range over moments of time; and *e*, *e'*...range over eventualities. One can make lambda abstracts in the usual way.

The rules for a small fragment of English are given below (an expression "*A**" denotes the *semantic translation* of *A*).

³⁰ Parsons later revises the interpretation of processes, so that the distinction between processes and events is dropped. The reasons for this are discussed in detail in section 5.

- R1: An intransitive VERB all by itself constitutes a VP. Its translation as a VP is the same as its translation as a VERB.
- R2: If A is a transitive VERB and B is a NAME, then AB is a VP, and the translation of AB is (AB)*, where
- $$(AB)^* = \lambda e[A^*(e) \ \& \ \text{Object}(B^*,e)]$$
- R3: If B is a NAME and A is a VP, then BA is an untensed CL, and:
If A is a Process or Stative VP, then
- $$(BA)^* = \lambda e\lambda t[A^*(e) \ \& \ \text{Agent}(B^*,e) \ \& \ \text{Hold}(e,t)]$$
- otherwise, if A is an Event VP, then
- $$(BA)^* = \lambda e\lambda t[A^*(e) \ \& \ \text{Agent}(B^*,e) \ \& \ \text{Cul}(e,t)]$$

Let us consider how these rules construct tenseless clauses of English. "Run" is an intransitive verb, and so by R1 it also constitutes a VP, whose translation is the same as that of "run", namely "Running*(e)", which should be read as "e is a running". "Win" is a transitive verb, which by rule R2 combines with the NAME "a race" to give a VP "win a race", whose translation is (9)³¹.

$$(9) \quad \lambda e[\text{Winning}^*(e) \ \& \ \text{Object}(\text{race}^*,e)]$$

(9) expresses the property of being a winning eventuality whose object is a race.

The VP "run" is classified as a *process* VP and the VP "win the race" is classified as an *event* VP. So by rule R3, (10) and (11) are tenseless CLs, which translate as (10a) and (11a) respectively.

- (10) Max run
(10a) $\lambda e\lambda t[\text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Hold}(e,t)]$
(11) Max win a race
(11a) $\lambda e\lambda t[\text{Winning}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Object}(\text{race}^*,e) \ \& \ \text{Cul}(e,t)]$

The rule R3 treats process VPs and event VPs differently. Because "run" is a process VP, the predicate Hold appears in the representation of (10), whereas, because "win the race" is an event VP, the predicate Cul appears in the representation of (11). (10a) relates any eventuality e and time t just in case e is a running whose agent is Max, and which *holds* at t. (11a) relates any eventuality e and time t just in case e is a winning whose agent is Max and object is a race, and which *culminates* at t.

³¹ The word "race" is traditionally represented as a predicate, but Parsons represents it as a term in order to simplify the analysis for his purposes.

It is important to stress that the *development portion* of an event has *no status* in the semantic translation of event CLs. According to rule R3, the logical form of the tenseless event clause (11) is (11a). (11a) features just the formula $\text{Cul}(e,t)$, standing for "e culminates at t", and it does *not* feature the formula $\text{Hold}(e,t)$, which would stand for "e is in development at t". Thus the semantics of (11) is characterised purely in terms of the culmination, and it is *not* characterised in any way in terms of the development portion. Hence the development portion plays no role in discriminating events; one can distinguish between events solely on the basis of their culminations.

Since the semantics of an event CL is fully specified in terms of the culmination, it looks as though Parsons' formalism is not making any use at all of the notion that an event has a development portion. But the situation is not quite that simple, thanks to the definition of the *progressive*. The progressive tenseless CL (12) is analysed so that it reports a state holding, which, ontologically speaking, is understood to be the development portion of winning the race being in progress.

(12) Max be winning the race

So although the development portion of an event plays no *logical* role in Parsons' theory, it plays a *metaphysical* role, and that is to help us understand in metaphysical terms what it means for a state of winning the race to hold.

The rule Parsons gives for introducing the progressive form of a verb is the following:

R7: If A is a non-stative VP, then be A-ing is a stative VP, whose translation is the same as A.

Changing a VP to the progressive simply reclassifies it as stative. The semantic translation of a progressive VP is the same as that for the corresponding non-progressive VP. For example, the VPs "be winning the race" and "win the race" are both translated as (9).

(9) $\lambda e[\text{Winning}^*(e) \ \& \ \text{Object}(\text{race}^*,e)]$

But because the progressive VP is *stative* and the nonprogressive one is an *event*, when one adds a NAME to the VPs to make tenseless CLs, rule R3 will assign the progressive CL and the non-progressive CL *different* semantic translations. The translation by rule R3 of (12) is (12a) and (11) translates as (11a).

- (12a) $\lambda e \lambda t [\text{Winning}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Object}(\text{race}^*, e) \ \& \ \text{Hold}(e, t)]$
 (11a) $\lambda e \lambda t [\text{Winning}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Object}(\text{race}^*, e) \ \& \ \text{Cul}(e, t)]$

The formulae (12a) and (11a) are the same, save that the formula $\text{Hold}(e, t)$ appears in (12a) and the formula $\text{Cul}(e, t)$ appears in (11a).

Parsons' analysis of the progressive acts as a "signal" that the clause should change to another form. It is a signal in the case of event clauses that the formula $\text{Cul}(e, t)$ should be replaced by the formula $\text{Hold}(e, t)$. Nothing appears in the final representation of a progressive VP that corresponds to the progressive itself. Thus by trading on the event ontology, Parsons assigns no scope properties to the progressive³².

Indeed, because the formulae $\text{Cul}(e, t)$ and $\text{Hold}(e, t)$ are not *logically* related, the progressive CL (12) is *not* logically related to the corresponding non-progressive clause (11), even though it is definable directly. However, they are *metaphysically* related. The formula $\text{Hold}(e, t)$ in (12a) corresponds to the *state* of winning the race holding at t , and this is understood metaphysically to mean that the development portion of the *event* of Max winning the race is in progress at t . The formula $\text{Cul}(e, t)$ in (11a) is interpreted as the *same* event culminating at t .

Rules R4 and R5 are used to construct *tensed sentences* from the tenseless CLs:

- R4: If A is a tenseless CL, then the past, present and future forms of A are tensed CLs, where

$$\begin{aligned} \text{Past}(A)^* &= \lambda e \lambda t (\exists t') [t' < t \ \& \ A^*(e, t')] \\ \text{Pres}(A)^* &= A^* \\ \text{Fut}(A)^* &= \lambda e \lambda t (\exists t') [t' > t \ \& \ A^*(e, t')] \end{aligned}$$

- R5: If A is a tensed CL, then $\#A\#$ is an S, where

$$(\#A\#)^* = \lambda t (\exists e) A^*(e, t)$$

In rule R5 above the expression " $\#A\#$ " is just the same string of words as A . Parsons has two ways of referring to the same string of words, because this string can be categorised as both a tensed CL and an S, and these denote different semantic objects.

³² This is in sharp contrast to the traditional view on the progressive, where it is regarded as a sentential modifier, cf. (Bennett and Partee 1972, Dowty 1979, Scott 1968, Vlach 1981).

For example (2) is a tensed CL and an S. Its translation as a tensed CL is (2a), and its translation as an S is (2b).

- (2) Max won the race
- (2a) $\lambda e \lambda t (\exists t') [t' < t \ \& \text{Winning}^*(e) \ \& \text{Agent}(\text{max}^*, e) \ \& \text{Object}(\text{race}^*, e) \ \& \text{Cul}(e, t')]$
- (2b) $\lambda t (\exists e) (\exists t') [t' < t \ \& \text{Winning}^*(e) \ \& \text{Agent}(\text{max}^*, e) \ \& \text{Object}(\text{race}^*, e) \ \& \text{Cul}(e, t')]$

(2a) describes a relation between times and eventualities, and (2b) describes a property of times. (2a) relates any eventuality e and time t just in case there is a time t' earlier than t such that e is a winning that holds at t' , with agent max and the race as the object. (2b) describes a property of times, and is true of a time t just in case there is an eventuality e and a time t' such that t' is earlier than t and e is a winning that holds at t' with agent max and the race as the object.

Translating the members of the syntactic category S into predicates of times rather than formulas in the semantics may seem a little mysterious. However, the intended application is the following: if A is an S then any given utterance of A is true (or false) of the time of utterance. Thus an utterance of sentence (2) is true if and only if (2b) is true of the time of utterance.

Now that we have discussed Parsons' rules for the progressive and tense, we are in a position to see how Parsons solves the imperfective paradox. Let us review how the formalism relates sentences (1) and (2), and (13) and (3).

- (1) Max was winning the race
- (2) Max won the race
- (13) Max was running
- (3) Max ran

The representation of (1) is (1a), and the representation of (2) is (2a).

- (1a) $\lambda t (\exists e) (\exists t') (t' < t \ \& \text{Winning}^*(e) \ \& \text{Agent}(\text{max}^*, e) \ \& \text{Object}(\text{race}^*, e) \ \& \text{Hold}(e, t'))$
- (2a) $\lambda t (\exists e) (\exists t') (t' < t \ \& \text{Winning}^*(e) \ \& \text{Agent}(\text{max}^*, e) \ \& \text{Object}(\text{race}^*, e) \ \& \text{Cul}(e, t'))$

(1a) and (2a) are the same, save that (1a) features the formula $\text{Hold}(e, t')$ and (2a) features the formula $\text{Cul}(e, t')$. This difference is a result of the fact that rule R3 treats *stative* VPs, such as progressive VPs, and *event* VPs differently. The formulae $\text{Hold}(e, t')$ and $\text{Cul}(e, t')$ are *unrelated* logically speaking, and so (1a) does not entail (2a), as required.

One intuitively feels, however, that there is an entailment from (2) to (1), and since the formulae $\text{Hold}(e, t')$ and $\text{Cul}(e, t')$ are logically unrelated, Parsons' formalism does not capture this

entailment within the realm of semantics. One could, however, explain the entailment, even though it would not be explained logically, by trading on the intuition that if an event culminates at the time t' , then it must have been in the development portion before t' . This intuition would be reflected in the formalism by assuming that whenever an event e satisfies the formula $\text{Cul}(e, t')$, then it satisfies $\text{Hold}(e, t'')$ for some time t'' earlier than t' . So although (2) doesn't *logically* entail (1), it does entail (1) modulo this assumption, and so one might feel generous to Parsons on this point.

The progressive form of a *process* sentence, on the other hand, is *semantically equivalent* to the corresponding non-progressive. This is a result of the fact that rule R3 treats *stative* VPs, such as progressive VPs, and *process* VPs in exactly the same way. The formalism assigns both sentences (13) and (3) the same translation, namely (13a).

(13a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Hold}(e, t'))$

Hence Parsons' analysis of the progressive explains an entailment from (13) to (3) and vice versa, as required. In this way, Parsons' theory solves the imperfective paradox. It achieves both the necessary tasks for solving the imperfective paradox, for it provides a semantic distinction between sentences (3) and (2) (sentence (3) features the predicate "Hold" and (2) features the predicate "Cul"), and the definition of the progressive is sensitive to this distinction between (3) and (2) (sentences (13) and (3) have the same logical form, but (1) and (2) do not).

5 The Analysis of Adverbials

We have seen how Parsons uses the Event-based Strategy to solve the imperfective paradox. But a solution to the imperfective paradox in *isolation* from an explanation of other temporal phenomena is not what one would want. His account of aspect, if it is to be satisfactory at all, must fit into a general theory of temporal reference. In particular, rules R3, R7, R5 etc. must fit with an account of adverbial modification. We must have a semantic representation of sentences like "Max ran slowly", "Max ran across the street" and "Max ran at 3pm". We will show that Parsons' formalism as it stands cannot adequately represent "Max ran across the street" and "Max ran at 3pm". Moreover, if one tries to modify his formalism in order to improve the representation of these sentences, then one loses the potential for solving the imperfective paradox. Thus, we will argue, Parsons' solution to the imperfective paradox is unworkable, since it cannot be stated in a formalism that at the same time gives semantic representations of "Max ran across the street" and "Max ran at 3pm".

To see how Parsons would account for "Max ran across the street", let us establish how he treats adverbial modification, and assess how this treatment interacts with rules R3, R7 etc. Parsons' framework assumes a Davidsonian treatment of adverb modification. Indeed, it is one of the aims of his theory to illustrate the virtues of such a treatment. Adverbials are regarded in the theory as *predicates* whose arguments range over *eventualities*. The following rule assigns semantic structures to sentences that include adverbials:

R8: If A is an adverbial and B is a VP, then BA is also a VP and
 $(BA)^* = \lambda e[B^*(e) \ \& \ A^*(e)]$

For example, the VP "sing softly" receives the semantic translation (14).

(14) $\lambda e[\text{Singing}^*(e) \ \& \ \text{Softly}^*(e)]$

So the representations of (15) and (16) are (15a) and (16a) respectively.

(15) Max sang softly

(15a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Singing}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Softly}^*(e) \ \& \ \text{Hold}(e, t)]$

(16) Max sang

(16a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Singing}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Hold}(e, t)]$

With these translations, one can explain the entailment from sentence (15) to (16) by the ordinary predicate calculus.

5.1 A Problem with Entailment

Although the rule for adverbial modification handles sentence (15) in the way we would desire, Parsons notes problems in the analysis of sentence (17).

(17) Max ran across the street

To see what the problem is, let us investigate how Parsons represents (17) in the semantic formalism.

Sentence (17) features a prepositional phrase. Parsons' rule for prepositional phrases, given below, takes a preposition and an object to form an adverbial.

R9: If P is a preposition and N is a NAME, then PN is an adverbial, and

$$(PN)^* = \lambda e[P^*(N^*, e)]$$

We intuitively feel that the VP "run across the street" must be an *event* VP, since there is no entailment from (18) to (17).

(18) Max was running across the street

So in the translation of (17), the *event* VP case of rule R3 must be used; i.e. the predicate featured in the translation of (17) must be Cul instead of Hold. So, using the rules Parsons has given so far, the representation of (17) is (17a).

(17a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Across}^*(\text{the street}^*, e) \ \& \ \text{Cul}(e, t')]$

In words, (17a) is a property of times which holds of a time t just in case there is a time t' such that t' is earlier than t and there is an eventuality e such that e is a running, the agent of e is Max, the 'spatial location' of e is across the street, and e culminates at t' .

Parsons observes that problems arise in the above analysis of (17) because of the classification of the VP "run" as a *process* VP. He argues that since "run" is a process VP, its semantic translation, i.e. $\lambda e\text{Running}^*(e)$, must be a property of *processes*. Therefore, if Running^* is a property of e (that is, $\text{Running}^*(e)$ is true), then e is a process. So according to Parsons' ontology, e *cannot culminate*. Therefore the formula (19) is *false* for every eventuality e and every time t' .

(19) $\text{Running}^*(e) \ \& \ \text{Cul}(e, t')$

But by the ordinary predicate calculus, if (17a) is true of a time t , then (19) is true of an event e and time t' . Hence, since (19) is always false, (17a) must be *false* for every time t . But sentence (17) can be true.

Parsons suggests that if we are to preserve the translation of (17) as (17a), then we must change our interpretation of the VP "run" so that (19) can be true. (19) can be true only if the VP "run" is classified as an event, so that the eventuality e that is a running can culminate. Hence the only way to rescue (17a) as the representation of (17), is to classify the VP "run" as an *event* and not a process.

Because "run" must be classified as an event and not a process, Parsons drops the distinction between processes and events, so that all processes are a species of events. He suggests that what we have been calling processes are in fact events, and what we have been calling process VPs are in fact events VPs, which have the property that when they are true of an event *e* they are often true of many 'subevents' of *e* which have the same agents and objects. For example, a running is now an event which typically consists of 'shorter' events which are also runnings. Parsons claims that typically, a running starts to *develop* when the agent starts running, and it *culminates* when the agent stops running. He proposes, however, that a running, like a street crossing, may terminate before its culmination if something interferes. Parsons suggests that "unculminated runnings do not occupy one's attention, since they typically have 'subrunnings' which do culminate".

What are the consequences of this re-classification of process VPs to event VPs? Since the process category has been abolished, rule R3 need not mention this option. So rule R3 is replaced by rule R3' below.

R3': If B is a NAME and A is a VP, then BA is an untensed CL, and:
If A is a stative VP, then

$$(BA)^* = \lambda e \lambda t [A^*(e) \ \& \ Agent(B^*,e) \ \& \ Hold(e,t)]$$

otherwise, if A is an event VP, then

$$(BA)^* = \lambda e \lambda t [A^*(e) \ \& \ Agent(B^*,e) \ \& \ Cul(e,t)]$$

Rule R3' treats CLs such as "Max run" differently to R3; it will use the predicate Cul in their translation instead of Hold. For example, the semantic representation of (3) is now (3b), and so now one can explain an entailment from (17) to (3) by the ordinary predicate calculus.

(3) Max ran

(3b) $\lambda t (\exists e)(\exists t')(t' < t \ \& \ Running^*(e) \ \& \ Agent(max^*,e) \ \& \ Cul(e,t'))$

But what effect does this have on Parsons' solution to the imperfective paradox?

As a result of the new rule R3', there is no longer a logical explanation of the entailment from (13) to (3).

(13) Max was running

(13) still receives the translation (13a).

(13a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Hold}(e, t'))$

So the representation of (3) features the predicate Cul whereas (13) features the predicate Hold. These predicates are logically unrelated, and so there is now no logical entailment from (13) to (3). Hence Parsons' solution to the imperfective paradox is undermined.

Parsons notices this problem, and suggests a way out. He suggests that although his formalism cannot explain a *logical* entailment from (13) to (3), one could explain a weaker entailment by incorporating into the formalism the principle that if an event *e* is a running, then *e* has 'subevents' that are runnings which culminate. So if (13) is true of a time *t*, then the event *e* that is a running has 'subevents' that are runnings that culminate, making (3) true.

One might feel generous to Parsons on this point, and accept this new explanation of the relationship between (13) and (3) that he has been forced into. But even if we do give Parsons the benefit of the doubt on the issue of sentences (13) and (3), there are still irresolvable problems with the new rule R3' that concern the question of *temporal adverbial modification*. Because we have been forced to drop the distinction between events and process, the representation of sentence (20) proves problematic, as I will now show.

(20) Max ran at 3pm

5.2 Temporal Adverbials

What is the representation of sentence (20)? Parsons does not offer an account of the temporal adverbial "At 3pm" in (Parsons 1984), the paper in which he offers an analysis of aspect. However, he does give an account in (Parsons 1980). The analysis of "At 3pm" in (Parsons 1980) is as follows: the point adverbial "At 3pm" is a basic expression whose translation is (21).

(21) $\lambda P \lambda e \lambda t (P(e, t) \ \& \ \text{AT3pm}(e, t))$

R10 is the rule for temporal adverbials.

R10: If A is a temporal adverbial and B is an tenseless CL, then the appropriate combination of A with B is a tenseless CL, and the combination of A with B translates as A*(B*).

According to rules R10 and R3', the semantic translation of sentence (20) is (20a) (since "run" is an event VP).

(20) Max ran at 3pm

(20a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{AT3pm}(e, t') \ \& \ \text{Cul}(e, t')]$

So when is (20a) true of a time t ?

According to Parsons, the formula $\text{AT3pm}(e, t')$ when e is an event is true if and only if e culminates at time t' , and t' is 3pm (Parsons 1980: p47). The time of culmination of a running is the time of termination of the running³³. So (20a) is true of a time t only if 3pm is the time of *termination* of the running. How does this square with our natural interpretation of (20)?

The natural interpretation of sentence (20) is an *inchoative* one; (20) is true if and only if Max *starts* to run at 3pm. But (20a) fails to explain this, for (20a) identifies 3pm as the time of *termination* of the running. If one is to achieve an adequate semantic interpretation of (20) in the theory, then the representation of (20) must identify 3pm with the time Max *starts* to run; i.e. 3pm must be the time when the running event e *starts to develop*. This places certain requirements on the interpretation of the formula $\text{AT3pm}(e, t')$: $\text{AT3pm}(e, t')$ must be true for an event e if and only if e *starts to develop* at time t' and t' is 3pm. According to Parsons' ontology, if an event e is developing at a time t' , then it cannot be culminating at t' (e develops over an open interval of time, and culminates at the final bound of that open interval). So if an event e starts to develop at t' , then $\text{Cul}(e, t')$ must be false. Hence under the new interpretation of $\text{AT3pm}(e, t')$ that the interpretation of (20) requires, the formulae $\text{AT3pm}(e, t')$ and $\text{Cul}(e, t')$ cannot both be true. So (20a) is *false* of any time t , and so it cannot be the representation of (20). Hence we have failed to give a satisfactory representation of sentence (20) under rule R3'.

However, had we kept the original classification of the VP "run", and so kept the original rule R3, then we would not have had a problematic analysis of (20). Under the original analysis, "run" is a process VP, and so under rule R3, (20) translates as (20b).

(20b) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{AT3pm}(e, t') \ \& \ \text{Hold}(e, t'))$

(20b) differs from (20a) in that (20b) features the formula $\text{Hold}(e, t')$ instead of $\text{Cul}(e, t')$. So suppose we interpret $\text{AT3pm}(e, t')$ so that if e is a process then t' is the time that e starts to hold and t'

³³ This is the only interpretation that squares with the culmination of events in general.

is 3pm. Then (20b) will identify 3pm as the time when the running starts to hold, which is just as required.

Under Parsons' original rule R3, we showed the representation (17a) of (17) is always false.

(17) Max ran across the street

(17a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Across}^*(\text{the street}^*, e) \ \& \ \text{Cul}(e, t'))$

We argued that there was only one thing we could do in order to preserve (17a) as the translation of (17), and that was to re-classify processes as events. This entailed changing rule R3 to R3', since the option for process VPs was no longer needed. But this change proved problematic for sentence (20).

(20) Max ran at 3pm

We could account for (20) under rule R3, but *not* under the new rule R3'. So re-classifying processes as events was not satisfactory. But this was the only way we could preserve (17a) as the representation of (17). We are, therefore, now forced to change the representation of (17) from (17a) to something else, in order to account for the fact that (17) can be true. But what could that something else be?

6 A Revised Representation

As the theory stands, (17a) is the representation of (17).

(17) Max ran across the street

(17a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Across}^*(\text{street}^*, e) \ \& \ \text{Cul}(e, t')]$

What changes are necessary to this representation, in order to account for the fact that (17) can be true? Suppose one revises the analysis of adverbials to a Montagovian treatment, as modifiers on predicates. The logical form of (17) is then (17b), where "Across-the-street*" is a modifier on predicates.

(17b) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Across-the-street}^*(\text{Running}^*)(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Cul}(e, t')]$

One can ensure that (17b) can be true only by assuming that there is *no entailment* from the formula (22) to (23).

- (22) Across-the-street*(Running*)(e)
 (23) Running*(e)

For suppose (22) *does* entail (23). Then (17b) entails there is an eventuality e and time t' such that the formulae Running*(e) and Cul(e, t') are both true. Since the VP "run" is now back to being a process, there is *no* such eventuality e , and so (17b) is always false. Hence (17b) is a satisfactory representation of (17) only if (22) does not entail (23). So, since (22) does not entail (23), (17b) cannot entail (3a), which is the representation of (3).

- (3) Max ran
 (3a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Running}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Hold}(e, t'))$

Revising Parsons' analysis of adverbials to the Montagovian treatment undermines his whole strategy. The aim of his theory is to show that quantification over eventualities is required in order to explain elegantly the entailment from sentence (17) to (3).

- (17) Max ran across the street
 (3) Max ran

But if (17b) is the logical form of (17), and if (22) does not entail (23), then one can't explain the entailment from (17) to (3). So (17b) is not a satisfactory representation of (17).

We have seen that changing Parsons' analysis of "across the street" in order to solve the problematic analysis of sentence (17) is not workable. The only other relevant thing that is available to change in the representation of (17) is the predicate "Cul". Parsons' 1980 formalism thus offers the *only plausible alternative* strategy that may solve the problematic analysis of sentence (17): The strategy is to replace *both* the predicates "Cul" and "Hold" with the *single* predicate "Occ" ("occurs") that appears in (Parsons 1980). Occ(e, t) can mean one of three things: either (i) e is an event which culminates at t (e.g. the event e of Max winning the race satisfies Occ(e, t) if Max crosses the finish line in first place at t), or (ii) e is a process which is going on at t (e.g. a running process e satisfies Occ(e, t) if the running is going on at t), or (iii) e is a state and e 's agent is in state e at t . Since Occ reports the culmination for an event, which was given by "Cul" in the original formalism, and Occ reports the holding of a process or state, which was given by "Hold", one can think of the predicate Occ as an *amalgamation* of the two predicates Cul and Hold.

Replacing the predicates Cul and Hold with Occ entails that rule R3 is replaced by rule R3_{occ} which is defined below.

R3occ: If B is a NAME and A is a VP, then BA is an untensed CL and

$$(BA)^* = \lambda t \lambda e [A^*(e) \ \& \ Agent(B^*, e) \ \& \ Occ(e, t)]$$

Under rule R3occ, the representations of (17) and (3) are (17c) and (3c) respectively.

- (17) Max ran across the street
 (17c) $\lambda t (\exists e) (\exists t') [t' < t \ \& \ Running^*(e) \ \& \ Agent(max^*, e) \ \& \ Across^*(the \ street^*, e) \ \& \ Occ(e, t')]$
 (3) Max ran
 (3c) $\lambda t (\exists e) (\exists t') [t' < t \ \& \ Running^*(e) \ \& \ Agent(max^*, e) \ \& \ Occ(e, t')]$

(17c) can be true, because under the new formalism an eventuality *e* can satisfy both *Running*^{*}(*e*) and *Occ*(*e*, *t*). Furthermore, (17c) entails (3c) by ordinary predicate logic, and so one has an explanation for the entailment from sentence (17) to (3). Therefore, this revised representation solves the problematic analysis of (17).

R3occ also provides a satisfactory representation of (20).

- (20) Max ran at 3pm

The representation of (20) is now (20c),

- (20c) $\lambda t (\exists e) (\exists t') (t' < t \ \& \ Running^*(e) \ \& \ Agent(max^*, e) \ \& \ AT3pm(e, t') \ \& \ Occ(e, t'))$

and under the assumption that for a process *e* the formula *AT3pm*(*e*, *t*') is true only if *e* *starts* to occur at *t*' (so *Occ*(*e*, *t*') is true) and *t*' is 3pm, (20c) captures the natural interpretation of (20) where Max *starts* to run at 3pm. But what are the ramifications of revising R3 to R3occ for Parsons' solution to the imperfective paradox?

6.1 The Progressive Revisited

Although changing R3 to R3occ solves the problems concerning the analyses of sentences (17) and (20), there are serious implications for the existing analysis of the progressive. One is no longer able to block the entailment from (1) to (2), because one no longer has the two logically unrelated predicates *Cul* and *Hold* in the formalism.

- (1) Max was winning the race

- (2) Max won the race

By replacing the predicates Cul and Hold with Occ in rule R3occ, the logical forms of sentences (1) and (2) are both (2c).

- (1) Max was winning the race
 (2) Max won the race
 (2c) $\lambda t(\exists e)(\exists t')[t' < t \ \& \text{Winning}^*(e) \ \& \text{Agent}(\text{max}^*, e) \ \& \text{Object}(\text{race}^*, e) \ \& \text{Occ}(e, t')]$

Hence the theory predicts an equivalence between sentences (1) and (2), and so the theory falls foul of the imperfective paradox.

Parsons was able to solve the imperfective paradox under the original rule R3. However, as he observed, this rule proved problematic in the analysis of sentence (17).

- (17) Max ran across the street

The only way to preserve the logical form of (17) was to re-classify process VPs as event VPs, and in so doing, change rule R3 to R3'. However, rule R3' proved problematic in the analysis of (20)

- (20) Max ran at 3pm

Therefore, we were left with no choice; we had to change the logical form of (17). The change that was found necessary was to *replace both* predicates Cul and Hold with *one* predicate, Occ. Thus the logical distinction between the predicates Cul and Hold was not sustainable, indicating that the predicates Cul and Hold must have been logically related after all. Rule R3 was revised to rule R3occ, and this solved the problematic interpretations of (17) and (20). But the progressive rule R7 and rule R3occ fall foul of the imperfective paradox: sentence (1) entails (2). Hence there seems to be no way in Parsons' theory of solving the imperfective paradox and at the same time accounting for sentences (17) and (20). Hence Parsons' formulation of the Event-based Strategy for solving the imperfective paradox fails, for it cannot fit together with an account of adverbial modification. In chapters 6 and 7, I will present a solution to the imperfective paradox that can square with an account of adverbial modification in a way that Parsons' theory can't.

Chapter 5

The Progressive and Universal Quantification

1 Introduction

The object of this chapter is to investigate how the progressive behaves in a sentence containing universally quantified noun phrases. Consider sentence (1).

- (1) Max was kissing every girl

Sentence (1) can have a *distributive* interpretation: (1) may be true when Max is kissing one girl at a time. Moreover under this distributive reading, (1) does not require that for every girl there is a time at which Max was kissing her; that is, sentence (1) does *not* entail (2).

- (2) Max was kissing Susan

To see that there is no inference from (1) to (2), consider the following state of affairs. Suppose that there is a queue of girls, Susan is last in the queue, and suppose that Max is in the process of kissing each girl in turn (so (1) is true). Suppose while he is doing this, something happens which stops him from ever being engaged in kissing Susan. Then (2) is false. Hence in the case of (1), *universal instantiation fails*³⁴.

The interpretation of (1) is in sharp contrast to its corresponding non-progressive form. Sentence (3) entails sentence (4).

- (3) Max kissed every girl
(4) Max kissed Susan

This indicates that the lack of inference from (1) to (2) must arise from the interaction of the progressive with the quantifier.

The objective of this chapter is to investigate how one might formulate the failure of

³⁴ It must be stressed that we are talking here about the 'simple past' sense of (2) rather than the futurate sense of (2) (which is synonymous with "Max was going to be kissing Susan"), and in line with the traditional view (cf. Dowty 1979), we assume that these two senses are semantically distinct. So universal instantiation fails because the 'simple past' sense of (1) does not entail the 'simple past' sense of (2).

universal instantiation in the case of (1). I will explore how one might represent sentence (1) in Parsons' (1980, 1984) analysis of a fragment of English, and then I will investigate the analysis of (1) given by Dowty (Dowty 1979). Parsons is adopting the *Event-based Strategy* in defining the progressive, which was discussed at length in the previous chapter, whereas Dowty adopts the *Eventual Outcome Strategy*, which was discussed in chapter 3. We established in these chapters that Parsons' and Dowty's theories were inadequate in certain respects, but in seeing which strategy best accounts for (1), we will nevertheless reveal some of the essential characteristics that should be embodied in an adequate alternative theory of the progressive. I start with Parsons' theory.

2 Parsons' Formalism

The details of Parsons' (1984) representation of a fragment of English were discussed at length in the previous chapter. I will just remind the reader of the parts of Parsons' theory that are relevant to our purposes here.

As discussed in the previous chapter, Parsons introduces an *eventuality ontology*. This ontology consists of three classes of eventualities: *events*, corresponding to Vendler's (1967) accomplishments and achievements (cf. "Max kissed every girl", "Max built a house"), *processes*, corresponding to Vendler's activities (cf. "Max ran"), and *states*, corresponding to Vendler's states (cf. "Max knew the answer").

These three types of eventualities have different ontological structures. An *event* may be divided into two parts, a *development portion* and a *culmination*. If Max builds a house, then there is a period of time during which the building is going on - the development portion - and then (if he finishes) a time at which the house finally gets built, the time of culmination. In contrast, *processes* and *states* cannot culminate. A process merely *goes on* and a state *holds*.

These ideas are reflected in the formalism with the aid of the predicates "Cul" and "Hold". The formula $Cul(e,t)$ means that the event e culminates at time t . The formula $Hold(e,t)$ can mean one of three things: either (a) e is an *event* which is in development at t , or (b) e is a *process* that goes on at time t , or (c) e is a *state* and e 's agent is in state e at time t . Parsons uses these formulae in interpreting a fragment of English.

For the sake of convenience, I repeat the relevant rules of Parsons' interpretation of a fragment of English below:

- R1: An intransitive VERB all by itself constitutes a VP. Its translation as a VP is the same as its translation as a VERB.
- R2: If A is a transitive VERB and B is a NAME, then AB is a VP, and

$$(BA)^* = \lambda e[A^*(e) \ \& \ \text{Object}(B^*,e)]$$
- R3: If B is a NAME and A is a VP, then BA is an untensed CL, and
 If A is a *process* or *state* VP, then

$$(BA)^* = \lambda e \lambda t[A^*(e) \ \& \ \text{Agent}(B^*,e) \ \& \ \text{Hold}(e,t)]$$

 If A is an *event* VP, then

$$(BA)^* = \lambda e \lambda t[A^*(e) \ \& \ \text{Agent}(B^*,e) \ \& \ \text{Cul}(e,t)]$$
- R4: If A is a tenseless CL, then the past, present and future forms of A are tensed CLs, where

$$\text{Past}(A)^* = \lambda e \lambda t(\exists t')[t' < t \ \& \ A^*(e,t')]$$

$$\text{Pres}(A)^* = A^*$$

$$\text{Fut}(A)^* = \lambda e \lambda t(\exists t')[t' > t \ \& \ A^*(e,t')]$$
- R5: If A is a tensed CL, then #A# is an S, where

$$(\#A\#)^* = \lambda t(\exists e)A^*(e,t)$$
- R7: If A is a non-stative VP, then be A-ing is a stative VP, whose translation is the same as A.

To remind ourselves of how these rules supply the semantics of natural language expressions, let us, for the sake of example, recap on the representations assigned to sentences (5) and (6).

- (5) Max built a house
 (6) Max was building a house

The above rules assign sentences (5) and (6) representations (5a) and (6a) respectively.

- (5a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{building}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Object}(\text{house}^*,e) \ \& \ \text{Cul}(e,t'))$
 (6a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{building}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Object}(\text{house}^*,e) \ \& \ \text{Hold}(e,t'))$

(5a) and (6a) both express a property of times. (5a) is true of a time t just in case there is a time t' earlier than t and an event e such that e is a building and the agent of e is Max and the object is the house and e culminates at t' . (6a) expresses the *same* property save that e must *hold* at t' instead of culminating. This analysis captures the intuition that (5) talks about the *culmination* of the event of Max building a house, whereas (6) talks about the *development portion* of the event of Max building a house.

The question for us is: What aspects of Parsons' analysis, if any, contribute to the explanation of the absence of inference from sentence (1) to (2)?

- (1) Max was kissing every girl
- (2) Max was kissing Susan

To answer this question, one must understand Parsons' analysis of quantification.

2.1 Parsons' Analysis of Quantifiers

Parsons does not give a treatment of quantifiers in (Parsons 1984), the paper in which he investigates the semantics of the progressive. However, he does offer an analysis of quantification in (Parsons 1980). The essential difference between the 1980 and 1984 formalisms is that in (Parsons 1980), an eventuality can merely *occur*, written $\text{Occ}(e,t)$, while in (Parsons 1984), an eventuality can *culminate* ($\text{Cul}(e,t)$) or *hold* ($\text{Hold}(e,t)$).

According to the Parsons' (1980) formalism, the formula $\text{Occ}(e,t)$ can mean one of three things: either (i) e is an event which culminates at t (e.g. a winning event e satisfies $\text{Occ}(e,t)$ if the winning culminates at t), or (ii) e is a process which is going on at t (e.g. a running process e satisfies $\text{Occ}(e,t)$ if the running is going on at t), or (iii) e is a state and e 's agent is in state e at t . Since in the 1980 theory Occ reports the *culmination* of an event, which is given by "Cul" in the 1984 formalism, and Occ reports the *holding* of a process or state, which is given by "Hold" in the 1984 formalism, one can think of the predicate Occ as an *amalgamation* of the predicates Cul and Hold .

In order to see how Parsons' treatment of quantifiers and the progressive interact, I shall incorporate Parsons' 1980 treatment of quantifiers into the 1984 formalism, in a way that still captures Parsons' intuitions concerning quantification. This essentially involves replacing the formula $\text{Occ}(e,t)$ with the formula $\text{Hold}(e,t)$ or $\text{Cul}(e,t)$, whichever is appropriate.

The intuitions that Parsons intends to capture in his analysis of quantification is that sentence (7) is about an *event* that is in some sense *composed* of each individual leaving event.

- (7) Every girl left

So the problem Parsons faces is to construct in the *formalism* the event that is the composite of each leaving event, such that the theory assigns an interpretation to (7) that agrees with intuitions.

According to intuitions, (7) can have a distributive reading, where it is true of a time t if the *last* girl leaves at t and every other girl left before t . Parsons aims to capture the distributive reading in the theory by assuming that the 'composite' leaving event that (7) refers to, whatever that is, should culminate when the last individual leaving event culminates.

On the other hand, Parsons suggests that sentence (8) is about a *process* that is in some sense composed of each individual humming process.

(8) Every girl hummed

According to intuitions, (8) can have a 'collective' reading, and under this reading it is true of a time t if every girl hums at t . Parsons intends to capture the collective reading of (8) by assuming that the composite process it refers to, whatever that is, is going on at a time t just in case each individual humming process is going on at t . It is not clear why Parsons chooses to capture the *distributive* reading of (7) but the *collective* reading of (8) in the *same* analysis of quantification. But we will gloss over this puzzle for now.

How is one to reflect these ideas in the formalism? How is a set of eventualities such as leavings and hummings to be composed into one leaving eventuality or humming eventuality in a way that agrees with the intuitions that we have just mentioned concerning sentences (7) and (8)? Let S be a non-empty set of eventualities, and let $\cap S$ be the composite eventuality constructed from the members of S . So, for example, if S is the set of leavings done by each girl, then the event $\cap S$ is the composite leaving event, i.e. the event of every girl's leaving, that Parsons wishes (7) to refer to. Then the question is: how is one to interpret when the eventuality $\cap S$ occurs? In other words, (with respect to the 1980 formalism for now), for what times t is $\text{Occ}(\cap S, t)$ true?

By using the process sentence (8) (under the collective reading) as an example, Parsons argues from an intuitive point of view that if S is a set of *processes*, then $\cap S$ is a process that is going on at a time t (i.e. $\text{Occ}(\cap S, t)$ is true) if for each process e contained in S , e is going on at t (i.e. $\text{Occ}(e, t)$ is true). Using the event sentence (7) (under the distributive reading) as an example, Parsons argues from an intuitive point of view that if S is a set of *events*, then $\cap S$ is an event and $\cap S$ culminates at t if one of the members of S culminates at t and every other member culminates before t ; i.e. $\text{Occ}(\cap S, t)$ is true if there is a member e of S such that $\text{Occ}(e, t)$ is true and for every other member e' of S , $\text{Occ}(e', t')$ is true from some t' earlier than t .

The intuition Parsons wishes to capture concerning sentence (9) is that it is about the *development portion* of the event of every girl's leaving.

(9) Every girl was leaving

Sentence (9) can have a distributive reading, and to capture this the event of everyone's leaving must be in development whenever one of the individual leavings is in development. This intuition can be generalised to the following: if S is a set of events, then the composite event $\cap S$ must be in development whenever one of the members of S is in development. Parsons' final analysis of quantification is an attempt to capture these ideas.

One more piece of notation is useful to Parsons' definition of quantifiers. Suppose that the set X is a class of *sets* of eventualities. Then Parsons offers the following definition:

$\cap^*X =_{df} \cap X'$, where X' is the *union* of the members of X , provided that each member of X is non-empty; otherwise \cap^*X is to be some eventuality that never occurs.

\cap^*X is defined in terms of \cap , *unless* X contains the empty set. The condition that every member of X should be non-empty will play the role in the analysis of (7) of ensuring that it is true only if every girl leaves at some time or other, i.e. for every girl there is a leaving that has that girl as the agent which occurs at some time or other. To see how \cap^* plays this role, consider how we should interpret (7). Suppose it is true. This means that every girl leaves at some time or other, and so for every girl, the set of *leaving* events that has that girl as the agent that occurs at some time is *non-empty*. Let X be the set of these sets of leavings. Then every member of X is non-empty. So \cap^*X is $\cap X'$, where X' is the union of the members of X . But $\cap X'$ is just the composite event of every girl's leavings, which is just the event that we want (7) to be about. Hence (7) must be about \cap^*X .

On the other hand, suppose that (7) is false. To show this in the theory, (7) must be about an eventuality which never occurs. Since (7) is false, there is a girl that never leaves; i.e. the set of all leaving events that has that girl as the agent that occurs at some time is *empty*. But this set is a member of X , where X is the set that contains for each girl, the set of all of her leavings that occur at some time. Hence by the definition of \cap^* , \cap^*X is an eventuality that never occurs. So, since (7) must be about an eventuality that never occurs, (7) again is about \cap^*X . Hence whether (7) is true or false, (7) must be about \cap^*X where X is the set that contains for each girl, the set of all of her leavings that occur at some time.

It is now clear what role the definition of \cap^* will play in the analysis of (7). When we review Parsons' rule for interpreting quantified noun phrases, we will see that it yields an analysis of (7) where it is indeed about \cap^*X , where X is the set that contains for each girl, the set of all of

her leavings that occur at some time. The condition that \cap^*X is an eventuality that occurs only if every member of X is non-empty guarantees that (7) is true only if for each girl there is some leaving event that has that girl as the agent that occurs at some time, which is just as required.

But before we can understand Parsons' final rule for interpreting "every girl", we must review his treatment of *common nouns* such as "girl". Common nouns stand for kinds of *states*. For example, "girl" translates into a relation between individuals and times, which holds between x and t just in case x is the agent of the state of being a girl which occurs at t . The rule Parsons offers in (Parsons 1980) is as follows:

R8: If A is a common noun, then A is a CN, and A translates as

$$\lambda x \lambda t (\exists e)(G(e) \ \& \ \text{Occ}(e,t) \ \& \ \text{Agent}(x,e))$$

where G is the symbol associated with A ; for example, if A is "girl" then G will be "girl*", where $\text{girl}^*(e)$ is paraphrased as "e is the state of being a girl". (Note that G is *not* the translation of A).

The interpretation of the formula $\text{Occ}(e,t)$ for a *state* e in the 1980 formalism is equivalent to the interpretation of the formula $\text{Hold}(e,t)$ in the 1984 formalism. Therefore, rule R8 is modified to R8' for the 1984 theory.

R8': If A is a common noun, then A is a CN. If G is the symbol associated with A then A translates as

$$\lambda x \lambda t (\exists e)(G(e) \ \& \ \text{Hold}(e,t) \ \& \ \text{Agent}(x,e))$$

For example, the common noun "girl" is translated as (10), where $\text{Girl}^*(e)$ is to be read as "e is the state of being a girl".

$$(10) \quad \lambda x \lambda t (\exists e)(\text{girl}^*(e) \ \& \ \text{Hold}(e,t) \ \& \ \text{Agent}(x,e))$$

(10) relates an individual x and time t , just in case there is a eventuality e such that e is the state of being a girl, x is the agent of e , and e holds at time t .

Consider again sentence (7).

(7) Every girl left

The event that (7) will be about in Parsons' analysis is \cap^*S , where S is the set containing for each girl, the set of all of her leavings that occur at some time (so S is $\{s: \text{for some girl, } s \text{ is the set of all of her leavings that occur at some time}\}$). The rule for quantification captures this, and also takes into account the analysis of common nouns given above. More specifically the rule Parsons offers for quantification in (Parsons 1980) is given below:

R9n: If A is a CN and if B is an untensed CL containing "it_n", then B_n^A is an untensed CL of the same type as B , where B_n^A is obtained from B by replacing the first "it_n" with "every A " and all later occurrences of it_n (if any) by a pronoun of the same gender as A .

B_n^A translates as:

$$\lambda e \lambda t (\text{Occ}(e, t) \ \& \ e = \cap^* \{s: (\exists x_n) (A^*(x_n, t) \ \& \ s = \{e': (\exists t') B^*(e', t')\})\})$$

Before incorporating rule R9n into Parsons' 1984 formalism, let us see how it represents the tenseless CL (11), so that we can understand the semantic roles of the formulae $A^*(x_n, t)$ and $s = \{e': (\exists t') B^*(e', t')\}$ in the above translation rule.

(11) Every girl leave

By rule R9n and rule R8 (we are translating according to the 1980 formalism for now), the tenseless CL (11) is translated as (11a).

$$(11a) \quad \lambda e \lambda t (\text{Occ}(e, t) \ \& \ e = \cap^* \{s: (\exists x_n) [(\exists e') (\text{girl}^*(e') \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Occ}(e', t)) \ \& \ s = \{e'': (\exists t') (\text{leaving}^*(e'') \ \& \ \text{Agent}(x_n, e'') \ \& \ \text{Occ}(e'', t'))\}]\})$$

The translation of (11a) can be paraphrased as follows: (11a) expresses a relation between an eventuality e and time t where e occurs at t and e is \cap^*S , where S is the set $\{s: \text{for an individual } x \text{ that is the agent of the state } e' \text{ of being a girl that occurs at } t, s \text{ is the set of leaving events } e'' \text{ that has } x \text{ as the agent, and } e'' \text{ occurs at some time } t'\}$. So the semantic role of the formula $A^*(x_n, t)$ in rule R9n is to assert that x_n is a girl, and the role of the set $s = \{e': (\exists t') B^*(e', t')\}$ is to identify the set of leaving events that has x_n as the agent that occurs at some time t' : this gives us just the definition of S that we want, i.e. S is the set that contains for each girl the set of all of her leavings that occur at some time.

This analysis of (11) captures just the intuitions Parsons desires. If one of the girls never leaves, then one of the members of the set S is empty, and so by the definition of \cap^* the eventuality e in (11a) never occurs. So (11a) is *false* for every eventuality e and time t , as required. On the other hand if every girl leaves at some time or other, then all the members of the set S are non-empty, and so by the definition of \cap^* , (11a) is about an eventuality e that is $\cap S'$ where S' is the union of the members of S , and as we discussed before, we interpret this composite event $\cap S'$ as culminating at the time t if there is a member e' of S' that culminates at t , and every other member of S' culminates before t . So (11a) is true of the event e and time t if t is the time when the last girl leaves and every other girl left before t . We know that such a time exists, since every girl leaves at some time. Hence (11a) is *true* for e and some time t , which is as required.

In order to see how Parsons would represent sentence (1), we must incorporate in the 1984 theory the rule R9n for quantification, which is given in the 1980 formalism.

(1) Max is kissing every girl

This is because the analysis of the progressive is stated in the 1984 formalism and not the 1980 one. How may Parsons' 1980 treatment of quantification be incorporated into the 1984 theory? Clearly, one must replace the formula $\text{Occ}(e,t)$ by the formula $\text{Cul}(e,t)$ or $\text{Hold}(e,t)$, whichever is appropriate. That is, if the composite eventuality e in the rule for quantification is an event, then "Occ" must be replaced by "Cul" (so that we still assert that the event e that (7) refers to culminates), and if the eventuality e is a process or state, then "Occ" must be replaced by the predicate "Hold". We replace "Occ" with "Cul" and "Hold" in the way desired by replacing rule R9n with R9n' defined below:

R9n': If A is a CN and if B is an untensed CL containing "it_n", then B_n^A is an untensed CL of the same type as B , where B_n^A is obtained from B by replacing the first it_n by "every A ", and all later occurrences of it_n (if any) by a pronoun of the same gender as A .

If B is a *process* or *state* CL, then

$$(B_n^A)^* = \lambda e \lambda t (\text{Hold}(e,t) \ \& \ e = \cap^* \{s: (\exists x_n) A^*(x_n, t) \ \& \ s = \{e': (\exists t') B^*(e', t')\}\})$$

Otherwise, if B is an *event* CL, then

$$(B_n^A)^* = \lambda e \lambda t (\text{Cul}(e,t) \ \& \ e = \cap^* \{s: (\exists x_n) A^*(x_n, t) \ \& \ s = \{e': (\exists t') B^*(e', t')\}\})$$

To reflect exactly in the 1984 formalism the intuitions behind the interpretation of the formula $\text{Occ}(\cap S, t)$ that was given in the 1980 theory, we assume the following: If $\cap S$ is a process or state then $\text{Hold}(\cap S, t)$ is true if and only if for *every* member e of S , $\text{Hold}(e, t)$ is true. If $\cap S$ is an event, then $\text{Hold}(\cap S, t)$ is true (i.e. $\cap S$ is in development at t) if for *some* member e of S , $\text{Hold}(e, t)$ is true (i.e. e is in development at t): this reflects the idea that the composite event $\cap S$ is in development if one member of S is in development. $\text{Cul}(\cap S, t)$ is true if for some member e of S $\text{Cul}(e, t)$ is true, and for every other member e' of S , $\text{Cul}(e', t')$ is true for some time t' earlier than t : this reflects the idea that the composite event $\cap S$ culminates when the last member of S culminates.

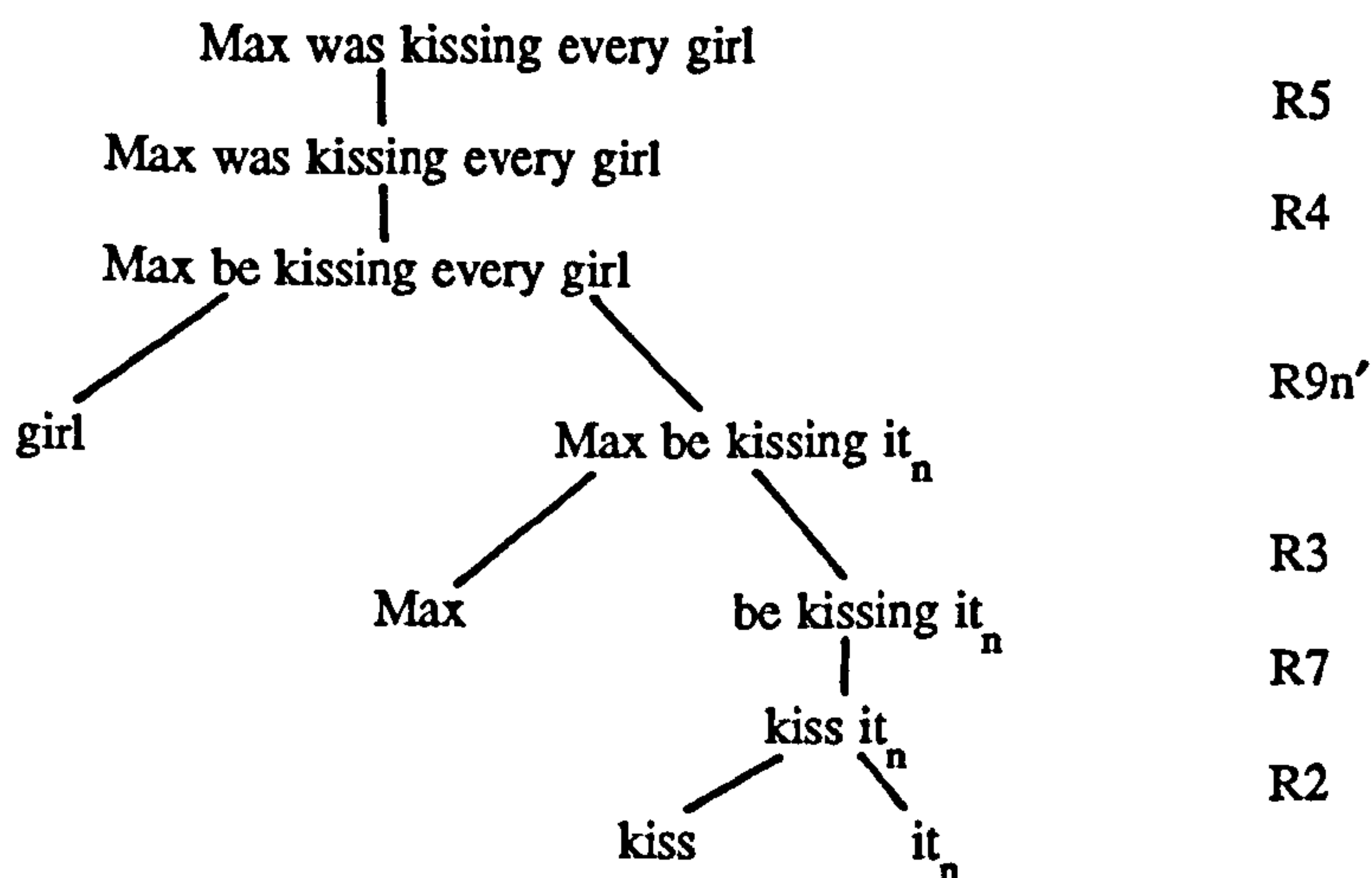
We have replaced rule R9n with the rule R9n' in order to incorporate Parsons' analysis of quantification into the 1984 theory. The change to rule R9n is just a consequence of replacing the one predicate Occ with two predicates, Cul and Hold . The rule R9n' still captures the intuitions concerning quantification elucidated in (Parsons 1980).

2.2 Parsons' Progressive and Quantification

I will now investigate the semantic analysis of (1), to see if Parsons can explain why the rule of universal instantiation fails with respect to it.

(1) Max was kissing every girl

To reflect how (1) is interpreted we might invoke the following tree.



In this chapter, we will not only have to talk about the semantic representation of (1), but we will also have to talk about the relations between its *syntactic constituents*. This is because we will ultimately have to modify Parsons' representation of (1), and this will involve revising the relations between its syntactic constituents in the hope that it will give rise to a change in the semantics that will get the results we want.

I will talk about the relation between (1)'s syntactic constituents in terms of the order in which the rules are applied in analysing (1) 'bottom-up', e.g. in the above tree the progressive rule R7 is applied *before* the quantification rule R9n'. One can intuitively think of this as quantification having *wider syntactic scope* than the progressive.

Now that we have discussed the relations between some of the syntactic constituents of (1), let us discuss (1)'s semantic representation. The semantic translation of (1) is as follows:

"kiss" translates as kissing*(e)	R1
"it" translates as x_n	Basic Expression
"Max" translates as max*	Basic Expression
"kiss it" translates as $\lambda e[\text{kissing}^*(e) \ \& \ \text{Object}(x_n, e)]$	R2
"be kissing it" translates as $\lambda e[\text{kissing}^*(e) \ \& \ \text{Object}(x_n, e)]$	R7
"Max be kissing it" translates as $\lambda e \lambda t[\text{kissing}^*(e) \ \& \ \text{Object}(x_n, e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Hold}(e, t)]$	R3
"girl" translates as $\lambda x \lambda t(\exists e)[\text{Girl}^*(e) \ \& \ \text{Agent}(x, e) \ \& \ \text{Hold}(e, t)]$	R8'
"Max be kissing every girl" translates as $\lambda e \lambda t[\text{Hold}(e, t) \ \& \ e = \cap^* \{s: (\exists x_n)[(\exists e')(\text{girl}^*(e') \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Hold}(e', t)) \ \& \ s = \{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Object}(x_n, e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Hold}(e'', t''))\}]\}]$	R9n'
"Max was kissing every girl" translates as (1a).	R4 and R5

$$(1a) \quad \lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Hold}(e, t') \ \& \ e = \cap^* \{s: (\exists x_n)[(\exists e')(\text{girl}^*(e') \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Hold}(e', t')) \ \& \ s = \{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Object}(x_n, e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Hold}(e'', t''))\}]\}]$$

In words, (1a) expresses a property of times, which is true of a time t just in case there is an eventuality e and time t' such that t' is earlier than t and e holds at t' , where e is the eventuality \cap^*S

and S is the set $\{s: \text{there is an individual } x \text{ such that } x \text{ is a girl at } t', \text{ and } s \text{ is the set of eventualities } e'' \text{ such that } e'' \text{ is a kissing with Max as the agent and } x \text{ as the object and } e'' \text{ holds at some time } t''\}$. This reflects the intuition that (1) is about the composite event made from the set S which contains for each girl, the set of all of her kissings by Max that hold at some time.

The rules R7 and R9n' fail to give a satisfactory account of the relationship between sentences (1) and (2).

- (1) Max was kissing every girl
- (2) Max was kissing Susan

According to the analysis so far, (1) entails (2), contrary to intuitions. This is shown as follows: Let S be the set (i) defined in (1a), which is the representation of sentence (1).

- (1a) $\lambda t(\exists e)(\exists t')[t' < t \ \& \ \text{Hold}(e, t') \ \& \ e = \cap^*$
- (i) $\{s: (\exists x_n)[(\exists e')(\text{girl}^*(e') \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Hold}(e', t')) \ \& \ s = \{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(x_n, e'') \ \& \ \text{Hold}(e'', t''))\}]\}$

Suppose that sentence (1a) is true of a time t_0 . Then formula (12) is true, for some eventuality e and some time t_1 earlier than t_0 .

- (12) $e = \cap^* S \ \& \ \text{Hold}(e, t_1)$

$\text{Hold}(e, t_1)$ is true. So by the definition of \cap^* , every member of S is non-empty, for otherwise $\cap^* S$ (which is e) would *not* hold for *any* time t_1 . Choose an arbitrary individual constant c^* , such that the formula (13) is true (i.e. " c is a girl").

- (13) $(\exists e')(\text{girl}^*(e') \ \& \ \text{Agent}(c^*, e') \ \& \ \text{Hold}(e', t_1))$

Then let s be the set of eventualities that are kissings, whose agent is Max and whose object is c^* which hold at some time t'' . i.e. s is the set (14).

- (14) $\{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Object}(c^*, e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Hold}(e'', t''))\}$

The set (14) is a member of S . Therefore, since all members of S are non-empty, formula (15) is true (i.e. there are eventualities that are kissings of c by Max which hold at t'').

(15) $(\exists e'')(\exists t'')(kissing^*(e'') \ \& \ Object(c^*,e'') \ \& \ Agent(max^*,e'') \ \& \ Hold(e'',t''))$

So, substituting the individual constant $susan^*$ for c^* (c^* was an arbitrary constant), we know that (15') is true.

(15') $(\exists e'')(\exists t'')(kissing^*(e'') \ \& \ Object(susan^*,e'') \ \& \ Agent(max^*,e'') \ \& \ Hold(e'',t''))$

Hence the formula (2a) is true of some time t later than t'' .

(2a) $\lambda t(\exists e'')(\exists t'')(t'' < t \ \& \ kissing^*(e'') \ \& \ Object(susan^*,e'') \ \& \ Agent(max^*,e'') \ \& \ Hold(e'',t''))$

But this is the representation of sentence (2).

(2) Max was kissing Susan

Hence sentence (1) entails sentence (2).

According to intuitions, the rule of *universal instantiation* fails with respect to (1). However, according to the analysis, the rule of universal instantiation does not fail, for (1) entails (2). How can we modify Parsons' analysis of the progressive and quantification to account for the lack of inference from (1) to (2)?

If one were to destroy the logical status of quantification, i.e. if we do not define " \cap^* ", but instead consider its interpretation to be primitive, then one would no longer have an entailment from (1) to (2). But then one is unable to explain entailments involving quantifiers that traditionally have been viewed as logical entailments, such as the entailment between (3) and (4).

(3) Max kissed every girl

(4) Max kissed Susan

Destroying the logical status of quantification is thus a heavy-handed attempt to solve the problem. How else may one account for the inferential properties of (1)? We will consider various definitions of the progressive in Parsons' framework, and show that for each of these definitions, one cannot provide an analysis of quantification which interacts with that definition to explain why universal instantiation fails for (1). So we will ultimately argue that Parsons' formulation of the Event-based Strategy fails on the analysis of (1).

3 Modifying Parsons' Analysis

What changes are necessary to the rules R7 and R9n' in order to explain why universal instantiation fails in the case of (1)? I start with rule R7.

3.1 R7 Must Not Classify the Progressive as Stative

By rule R7, sentence (1) is classified as *stative*. This is because (1) refers to an eventuality \cap^*S , where the members of S are the eventualities representing "Max be kissing x " for each girl x . By rule R7, these eventualities are states. Hence (1) refers to \cap^*S where the members of S are states, and so, according to Parsons' theory, \cap^*S is a state.

But stative sentences containing universal quantifiers do not display the inferential properties of (1). For example, sentence (16) entails (17), and so, unlike (1), the rule for universal instantiation applies.

- (16) Max loved every girl
- (17) Max loved Susan

The fact that (1) and (16) are different in this way causes problems for Parsons' account. The rule R9n' for quantification applied to the CL "Max be kissing it_n " gives the representation of (1), and R9n' applied to the CL "Max love it_n " gives the representation of (16). But *however* R9n' is defined, Parsons will not be able to explain why R9n' applied to "Max be kissing it_n " has different semantic import from R9n' applied to "Max love it_n ", because thanks to rule R7 the CLs "Max be kissing it_n " and "Max love it_n " are semantically indistinguishable (they are both stative). Hence under rule R7, Parsons cannot explain why (1) and (16) have different entailments.

On the other hand, if we change R7 so that the progressive is no longer classified as stative, then CLs like "Max be kissing it_n " are different from sentences like "Max love it_n " because they are of different aspectual classes. We might then be able to define the rule R9n' so that R9n' applied to the CL "Max be kissing it_n " has different semantic import from R9n' applied to "Max love it_n "; hence (1) and (16) would have different semantic import.

What implications does this have for Parsons' analysis of the progressive? Could one revise the aspectual classification of progressive VPs in the rule R7 so that they are no longer stative, and still preserve Parsons' intuitions concerning the progressive?

This puzzle is related to another issue: the relation between the *syntactic* constituents in the analysis of (1), which are given in the above derivation tree. The rule R9n' for quantification is applied after the rule R7' in the analysis of (1) (where we use the convention of going 'bottom-up' with respect to the above analysis tree).

(1) Max was kissing every girl

We have argued, however, that we must change rule R7 because we must change the aspectual classification of progressive VPs. Could one do this, and still preserve not only Parsons' intuitions concerning the progressive, but also the relations between the *syntactic* constituents of (1)?

Suppose that B is a NAME and A is an event VP. Then the intuition Parsons wishes to capture is that "B be A-ing" asserts that the event is in development and *not* culminating. To capture this, rule R7 may be revised as follows:

R7': If B is a name and A is a non-stative VP, then "B be A-ing" is an untensed CL of the same aspectual type as A, and

$$(B \text{ be } A\text{-ing})^* = \lambda e \lambda t (A^*(e) \ \& \ \text{Agent}(B^*, e) \ \& \ \text{Hold}(e, t))$$
³⁵

Rule R7' captures the above intuition because the predicate Hold is featured in the semantic translation of the event case of "B be A-ing" and not the predicate Cul, indicating that the event is in development and not culminating. Thus rule R7' still captures Parsons' intuitions even though, unlike his original analysis, progressive sentences are no longer classified as stative. Hence now the rule for quantification may be sensitive to the distinction between "Max be kissing it_n", which is about an event in development, and "Max love it_n", which is about a state.

Although R7' gives the logical form of whole progressive *clauses*, instead of getting down to the logical form of progressive VPs, the order of application of rules R7' and rule R9n' is preserved in the analysis of (1). Hence rule R7' not only captures the intuitions Parsons desires, but it also preserves the relations between the *syntactic* constituents in the analysis of (1).

How does rule R7' fare against the data? We will now investigate the interaction between R7' and R9n', and we will show that they cannot account for the fact that universal instantiation fails with respect to (1). The representation of sentence (1) is still (1a), where S is defined, informally speaking, as the set {s: for each girl, s is the set of kissings of her by Max which hold at

³⁵ We assume here that the classification of aspect classifies clauses as well as verb phrases.

some time t'').

$$(1a) \quad \lambda t(\exists e)(\exists t')(t < t' \ \& \ \text{Hold}(e, t') \ \& \ e = \cap^* S)$$

The representation appears to be exactly the same as the original representation, but there is one crucial difference: the aspectual category of the sentence has been revised from a state to an event (in development).

Even so, given the current analysis of quantification, (1) entails (2).

$$(2) \quad \text{Max was kissing Susan}$$

For if (1a) is true of a time t_0 , then $\cap^* S$ holds for some time t_1 . But by the definition of \cap^* , $\cap^* S$ holds at some time t_1 only if every member of S is non-empty. So for each girl, there exists some event e_1 which is a kissing of her by Max which holds at some time t_2 . In particular, there is some time t_2 such that a kissing event e_1 that has Max as the agent and Susan as the object holds at t_2 . Hence (2a), the representation of (2), is true of some time t_3 which is earlier than t_2 .

$$(2a) \quad \lambda t(\exists e'')(\exists t'')(t'' < t \ \& \ \text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(\text{susan}^*, e'') \ \& \ \text{Hold}(e'', t''))$$

So (1) entails (2).

Suppose one were to preserve rule R7'. Then how may one modify the existing analysis of *quantification* to explain the inferential properties of sentence (1)? The problem Parsons has in accounting for the inferential properties of (1) arises directly from the fact that he treats the eventuality $\cap^* S$ in terms of its *existential import*: by the definition of \cap^* , $\cap^* S$ can hold only if every member of S is non-empty. But by the definition of S in the representation of (1), every member of S is non-empty only if every member of S contains an event that holds at some time (i.e. every girl has a corresponding kissing event that holds at some time). In the case of (1) we know that interpreting the eventuality $\cap^* S$ in these terms will not work.

How could we revise our definition of when $\cap^* S$ holds in the representation of (1), so that it is *not* characterised in terms of *every* member of S being non-empty and therefore every member of S containing an event that holds at some time? We must either change the definition of \cap^* , or change the definition of S in the analysis of (1). Given Parsons' Davidsonian framework, there seem to be no plausible changes to the definition of S ³⁶. However, one might try to change the definition of \cap^* . The occurrence of the eventuality $\cap^* S$ should *not* depend on *every* member of S

being *non-empty*; by doing this we destroy the existential import of \cap^*S and we no longer impose the condition that \cap^*S can hold only if every member of S contains an event that holds at some time. Does this change improve the analysis of (1)?

3.2 A Change to the Definition of \cap^*

Sentence (1) reports an event in development, and so one should modify the definition of \cap^* in the way we described only for the event in development case. Thus \cap^*X is defined as follows:

When X is a class of sets of processes or states or events that culminate, then $\cap^*X =_{df} \cap X'$, where X' is the union of the members of X , provided that each member of X is non-empty; otherwise \cap^*X is to be some eventuality that never holds.
 When X is a class of sets of events that are in development, then $\cap^*X =_{df} \cap X'$, where X' is the union of the members of X , *regardless of whether or not the members of X are non-empty*.

Let us investigate what follows from the changed interpretation of \cap^* . One no longer obtains an entailment from sentence (1) to (2).

- (1) Max was kissing every girl
- (2) Max was kissing Susan

The representation of (1) is still (1a).

- (1a) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Hold}(e, t') \ \& \ e = \cap^*$
- (i) $\{s: (\exists x_n)[(\exists e')(\text{Girl}^*(e') \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Hold}(e', t')) \ \& \ s =$
- $\{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(x_n, e'') \ \& \ \text{Hold}(e'', t''))]\}$

But now by the new definition of \cap^* , (1a) may be true and the set (14) (the set of kissings of Susan by Max that hold at some time) may be empty, even though (14) is contained in the set (i) defined in (1a) above.

³⁶ If one did not wish to preserve the Davidsonian semantics, one could entertain the possibility of revising the definition of S so that S is the set $\{s: \text{for each girl, } s \text{ is the set of possible kissings of her by Max}\}$. The idea is that under the new analysis eventualities may exist without *actually* happening, and instead they *possibly* happen. So even if \cap^*S holds making (1) true, and so by the definition of \cap^* every member of S is non-empty, there is no guarantee that there is a kissing of Susan by Max that actually holds, and so (2) may be false. Developing this strategy would involve incorporating possible worlds into Parsons' ontology. This is a departure from Davidsonian semantics, and fairly extensive revisions of the framework would be required. For this reason, I do not investigate this strategy here. One can, however, show that it is inadequate.

$$(14) \quad \{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(\text{susan}^*, e'') \ \& \ \text{Hold}(e'', t''))\}$$

If (14) is empty, then (2a), which is the representation of (2), is false for all times t .

$$(2a) \quad \lambda t(\exists e)(\exists t')(\text{kissing}^*(e) \ \& \ \text{Agent}(\text{max}^*, e) \ \& \ \text{Object}(\text{susan}^*, e) \ \& \ \text{Hold}(e, t'))$$

Hence there is no entailment from sentence (1) to (2).

But now one obtains an entailment from (2) to (1), which is clearly undesirable. If (2) is true, then (2a), which is the representation of (2), is true of a time t_1 . So there is an event e_1 and a time t_2 (earlier than t_1) such that (18) is true.

$$(18) \quad \text{kissing}^*(e_1) \ \& \ \text{Agent}(\text{max}^*, e_1) \ \& \ \text{Object}(\text{susan}^*, e_1) \ \& \ \text{Hold}(e_1, t_2)$$

We now show that (2a) entails (1a). Let S be the set defined by (i) in (1a). By the new definition of \cap^* , \cap^*S is $\cap S'$ where S' is the union of the members of S (regardless of whether the members of S are non-empty). So (1a) is true of a time t if there is a time t' earlier than t such that $\text{Hold}(\cap S', t')$ is true. By the interpretation of when the *event* $\cap S'$ is in development, $\text{Hold}(\cap S', t')$ is true for a time t' if there is a member e'' of S' such that $\text{Hold}(e'', t')$ is true. But since the event e_1 that makes (18) true is contained in the set (14) that is a member of S , e_1 is a member of S' . Furthermore, $\text{Hold}(e_1, t_2)$ is true (since (18) is true). Hence by the interpretation of when the event $\cap S'$ is in development, $\text{Hold}(\cap S', t_2)$ is true. Hence (1a) is true of the time t_1 where t_2 is earlier than t_1 . Hence (1) is true, and so (2) entails (1).

We argued (in section 3.1) that if one is to fix rule R7', then the only way we could possibly account for the inferential properties of (1) is to revise the definition of \cap^* , so that if \cap^*X is about an event in development, then it can hold even if some members of X are empty. But we have shown here that such a definition for \cap^* fails. So we must preserve Parsons' original definition of \cap^* and change rule R7'.

In defining rule R7' in the way we did, we were attempting to preserve Parsons' original analysis of the *syntactic structure* of (1). This syntactic analysis corresponds intuitively to the quantifier having 'wider syntactic scope' than the progressive. But this has failed, indicating that if Parsons' formalism is to account for (1) at all, then it must do so with a different syntactic analysis. One might try to modify the theory so that the rule for the progressive dominates the rule for quantification in the analysis of (1). This would correspond intuitively to the progressive having 'wider syntactic scope' than the quantifier. It is hoped that changing the relations between the

syntactic constituents of (1) in this way will result in a change in the *semantic* interaction between the progressive and quantification which will get the results we want.

Changing the syntactic analysis of (1) involves re-defining the rules so that they have different input, and so they can be applied in different places in the derivation of (1). So two questions now arise: (i) How can we change rule R7' so that it still captures the intuitions Parsons desires, but we derive the representation of (1) in such a way that the progressive rule *dominates* the quantification rule, and (ii) if we were to do this, would it improve the analysis of (1)?

3.3 Changing the Syntax

We will show that the following rule R7'' captures Parsons' intuition on the progressive, but it can *dominate* the rule for quantification in the analysis of (1) because it has different input (CLs) to Parsons' original progressive rule R7, which took VPs as input.

R7'': If A is an untensed non-stative CL, then the progressive form of A is a CL of the same aspectual class as A and its semantic translation is the same as A* would have been if A were an untensed *state* CL.

Rule R7'', like the other rules for the progressive we have entertained, still captures the idea that the progressive form of a sentence denoting an event asserts that that event is in development and *not* culminating. To see how this works, consider how it transforms the non-progressive CL (19) to the progressive CL (20).

- (19) Max build a house
- (20) Max be building a house

(19) is an *event* CL, and the representation of (19) is (19a).

(19a) $\lambda e \lambda t (\text{building}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Object}(\text{house}^*,e) \ \& \ \text{Cul}(e,t))$

By rule R7'', (20) is an event CL, and the representation of (20) is the same as the representation of (19) would have been if (19) were a state CL. If (19) were a state CL, then rule R3 would translate it as (20a), and therefore (20a) is the representation of (20).

(20a) $\lambda e \lambda t (\text{building}^*(e) \ \& \ \text{Agent}(\text{max}^*,e) \ \& \ \text{Object}(\text{house}^*,e) \ \& \ \text{Hold}(e,t))$

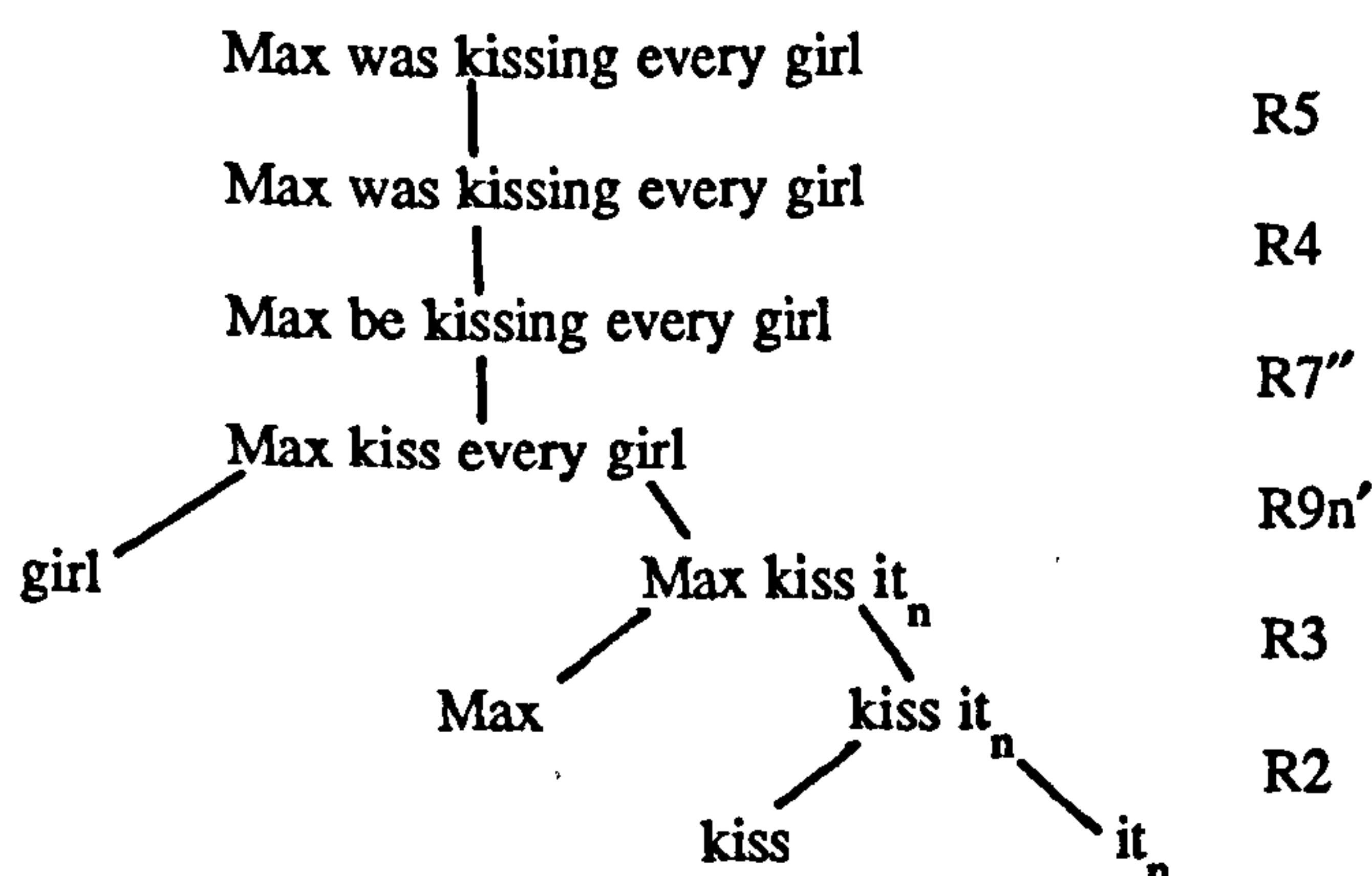
(19a) and (20a) are the same save that the formula $Cul(e,t)$ appears in (19a) and $Hold(e,t)$ appears in (20a). Thus rule $R7''$ captures the intuitions concerning the progressive that Parsons desires.

(19a) and (20a) were the translations of (19) and (20) under the original rule for the progressive, and so we don't seem to have changed the analysis at all. However, there is a crucial difference between $R7''$ and the original analysis: $R7''$ is different from $R7'$ in that it can dominate the rule for quantification in the representation of (1) whereas $R7'$ cannot.

(1) Max was kissing every girl

This difference in the syntax may give rise to the desired change in the semantics of (1). Is this the case?

The representation of sentence (1) is derived as follows; note that the rule $R7''$ dominates the rule for quantification.



The new translation of (1) is as follows:

"Max kiss it_n" translates as as before

$\lambda e \lambda t [kissing^*(e) \ \& \ Agent(max^*,e) \ \& \ Object(x_n,e)]$

"Max kiss every girl" translates as $R9n'$

$\lambda e \lambda t (Cul(e,t) \ \& \ e = \cap^* \{s: (\exists x_n) (\exists e') (girl^*(e) \ \& \ Agent(x_n,e') \ \& \ Hold(e',t) \ \& \ s = \{e'': (\exists t'') (kissing^*(e'') \ \& \ Object(x_n,e'') \ \& \ Agent(max^*,e'') \ \& \ Cul(e'',t''))\})\})])$

"Max be kissing every girl" translates as $R7''$

$\lambda e \lambda t (Hold(e,t) \ \& \ e = \cap^* \{s: (\exists x_n) (\exists e') (girl^*(e) \ \& \ Agent(x_n,e') \ \& \ Hold(e',t) \ \& \ s = \{e'': (\exists t'') (kissing^*(e'') \ \& \ Object(x_n,e'') \ \& \ Agent(max^*,e'') \ \& \ Cul(e'',t''))\})\})])$

"Max was kissing every girl" translates as (1b)

R4 and R5

- (1b) $\lambda t(\exists e)(\exists t')(t' < t \ \& \ \text{Hold}(e, t') \ \& \ e = \cap^*$
(ii) $\{s: (\exists x_n)(\exists e')(\text{girl}^*(e) \ \& \ \text{Agent}(x_n, e') \ \& \ \text{Hold}(e', t)) \ \& \ s =$
 $\{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Object}(x_n, e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Cul}(e'', t''))\}\}$

(1b) is different from the previous analysis, in that the events e'' in the set (ii) above are described in terms of the predicate Cul instead of Hold. This change in the semantics is a direct result of the change we have proposed in the syntax.

But the analysis of sentence (1) presented here does not account for its natural inferential properties. There is the same problem in using R7'' as was encountered with R7'. To see this, consider the case when (1b) is true of a time t . Then the event \cap^*S , where S is the set denoted by (ii) above, holds at some time t' earlier than t . By the (original) definition of \cap^* , $\text{Hold}(\cap^*S, t')$ is true only if each member of S is *non-empty*. In particular, the set (21) below is non-empty.

- (21) $\{e'': (\exists t'')(\text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(\text{susan}^*, e'') \ \& \ \text{Cul}(e'', t''))\}$

Thus there exists a time t_0 of which the predicate (4a) is true.

- (4a) $\lambda t(\exists e'')(\exists t'')(t' < t \ \& \ \text{kissing}^*(e'') \ \& \ \text{Agent}(\text{max}^*, e'') \ \& \ \text{Object}(\text{susan}^*, e'') \ \& \ \text{Cul}(e'', t''))$

But (4a) is the logical form of (4).

- (4) Max kissed Susan

Thus there is an entailment from (1) to (4), contrary to intuitions. Changing the relation between the syntactic constituents in the analysis of (1) has therefore failed to give the change in the semantics that we want.

The problem in analysing (1) with rule R7'' is exactly the same as the problem in using rule R7', and that is that the event \cap^*S has *existential import*. By the definition of \cap^* , the eventuality \cap^*S in (1b) holds at a time t' only if all the members of S are non-empty, and by the definition of S in (1b) this is the case only if all the members of S contain an event that culminates at some time, and so one cannot account for the failure of universal instantiation in the case of (1). As we argued before, one could try to overcome this by changing the definition of \cap^* , so that one relaxes

the condition that \cap^*S holds only if *every* member of S is non-empty (so one relaxes the condition that every member of S contains an event that culminates at some time). But I have already argued that this revision is not satisfactory, for then one obtains an entailment from (2) to (1), which is clearly contrary to intuitions.

We have tried to account for the inferential properties of sentence (1) while preserving Parsons' Event-based Strategy in defining the progressive. However, with every possible definition of the progressive under this strategy that we entertain, we come up against the same problem: the rule for quantification cannot be defined so that we explain the lack of inference from (1) to (2). So Parsons' formulation of the Event-based Strategy in defining the progressive fails on the analysis of (1). Hence a puzzle remains: How may one account for the inferential properties of the progressive with universal quantification?

4 Dowty's Progressive and Universal Quantification

Dowty's (1979) Eventual Outcome analysis of the progressive accounts for the inferential properties of (1) with a standard analysis of quantifiers.

(1) Max was kissing every girl

We will show this by deriving the representation of the 'tenseless' sentence (22) (note that (22) is categorised as a tenseless sentence in Dowty's framework because its representation does not invoke a tense operator).

(22) Max is kissing every girl

Dowty's analysis of (22) is derived from the representation of the sentence "Max kisses her", the progressive operator PROG and the standard analysis of quantification. According to Vendler (1967), the sentence "Max kisses her" denotes an *achievement*, and therefore it is represented in Dowty's theory using the sentential operator BECOME, with the truth conditions defined below³⁷:

[BECOME Φ] is true at the interval I if and only if there is an interval J which contains the initial bound of I such that Φ is false at J , and there is an interval K containing the final bound of I such that Φ is true at K .

"Max kisses her" is represented as [BECOME kissed'(x,max')], where the formula kissed'(x,max') corresponds to the state that x (i.e. she) has been kissed by Max (note that kissed' is a stative predicate).

The quantifier and the operators PROG and BECOME all have sentential scope, and so there are several representations of (22) that one could entertain due to the possible scope relations between them. The possible representations of (22) are listed below, where the formula kissed'(x,max') corresponds to the state that x has been kissed by Max³⁸.

- (22) Max is kissing every girl
- (22a) [PROG (∀x)(girl'(x) → [BECOME kissed'(x,max')])]
- (22b) (∀x)[PROG (girl'(x) → [BECOME kissed'(x,max')])]
- (22c) (∀x)(girl'(x) → [PROG [BECOME kissed'(x,max')]])
- (22d) [PROG (∀x)[BECOME (girl'(x) → kissed'(x,max'))]]
- (22e) (∀x)[PROG [BECOME (girl'(x) → kissed'(x,max'))]]
- (22f) [PROG[BECOME (∀x)(girl'(x) → kissed'(x,max'))]]

Which formula captures the natural interpretation of (22)? Are all these formulae semantically distinct?

Dowty's truth conditions for PROG were discussed at length in chapter 3. The definition is repeated below:

PROG(A) is true at $\langle I, w \rangle$ if and only if there exists an interval I' such that I is contained in I' but I is not a final subinterval of I' , and for all $w' \in \text{Inr}(\langle I, w \rangle)$, A is true at $\langle I', w' \rangle$.

Given this definition for PROG, one can show that for any formula Φ , the following entailment holds:

$$\text{PROG}(\forall x)\Phi \rightarrow (\forall x)\text{PROG}\Phi$$

Suppose that $\text{PROG}(\forall x)\Phi$ is true at an index $\langle I, w \rangle$ with respect to the model M and assignment function g . This holds if and only if there is an interval I' containing I such that I is not the final subinterval of I' and for every world $w' \in \text{Inr}(\langle I, w \rangle)$, $(\forall x)\Phi$ is true at $\langle I', w' \rangle$ with respect to M and g ; this is the case if and only if Φ is true at $\langle I', w' \rangle$ with respect to M and every g' exactly like g .

³⁷ The truth conditions for BECOME were examined in detail in chapter 2.

³⁸ One intuitively feels that "Max kisses every girl" denotes an *accomplishment*, and so one might think that (22) should be represented in Dowty's theory using not only the operator BECOME but the operator CAUSE as well (since this operator also normally features in the logical form of accomplishments). However, Dowty's grammar does not allow for this possibility, because "Max kisses her" is an achievement and the analysis of quantification is such that it cannot affect the aspectual class of a sentence.

except possibly in the value assigned to x . But by the definition of PROG, this entails that $\text{PROG}\Phi$ is true at $\langle I, w \rangle$ with respect to M and every g' that is like g except possibly in the value assigned to x , and this holds if and only if $(\forall x)\text{PROG}\Phi$ is true at an index $\langle I, w \rangle$ with respect to M and g . Hence $\text{PROG}(\forall x)\Phi$ entails $(\forall x)\text{PROG}\Phi$. Hence (22a) entails (22b) and (22d) entails (22e).

The universal quantifier has wide scope in (22b), (22c) and (22e), and so we know that these formulae cannot represent the readings of (22) where universal instantiation fails (we formally prove that universal instantiation applies to (22b), (22c) and (22e) in appendix 4). So by the above entailment, (22a) and (22d) also cannot explain why universal instantiation fails with respect to (22). This leaves just one possible representation for the reading of (22) where universal instantiation fails; namely (22f).

Let us investigate the truth conditions of (22f). (22f) is true at $\langle I, w \rangle$ with respect to M and g if and only if there is an interval I' containing I such that I is not a final subinterval of I' and for all $w' \in \text{Inr}(\langle I, w \rangle)$, (22f1) is true at $\langle I', w' \rangle$.

(22f1) $[\text{BECOME } (\forall x)(\text{girl}'(x) \rightarrow \text{kissed}'(x, \text{max}'))]$

(22f1) is true at $\langle I', w' \rangle$ if and only if there is an interval J containing the initial bound of I' such that (22f2) is false at $\langle J, w' \rangle$, and there is an interval K containing the final bound of I' such that (22f2) is true at $\langle K, w' \rangle$.

(22f2) $(\forall x)(\text{girl}'(x) \rightarrow \text{kissed}'(x, \text{max}'))$

Let us investigate the relationship between (22f) and the formula (23a), which is the representation of (23) (the formula $\text{kissed}'(\text{susan}', \text{max}')$ corresponds to the state that Susan has been kissed by Max).

(23) Max is kissing Susan

(23a) $[\text{PROG } [\text{BECOME } \text{kissed}'(\text{susan}', \text{max}'))]$

Suppose that (22f) is true at $\langle I, w \rangle$ with respect to M and g . It is consistent with the truth of (22f) at $\langle I, w \rangle$ with respect to M and g that $\text{kissed}'(\text{susan}', \text{max}')$ is true at all times in all the $w' \in \text{Inr}(\langle I, w \rangle)$. For even though (22f2) is false at $\langle J, w' \rangle$, this may be due to the fact that Max has not kissed Jane, and not the fact that Max has not kissed Susan. Suppose that $\text{kissed}'(\text{susan}', \text{max}')$ is true at all times in all the inertia worlds w' to $\langle I, w \rangle$. Then the formula (24) is false at all times in

$w' \in \text{Inr}(\langle I, w \rangle)$, and therefore by the definition of PROG, (23a) is false at all times in w with respect to M and g .

- (24) [BECOME kissed'(susan',max^)]
- (23a) [PROG [BECOME kissed'(susan',max^)]]

Hence (22f) does not entail (23a), and thus we have an explanation for why (22) does not entail (23).

- (22) Max is kissing every girl
- (23) Max is kissing Susan

We have found that (22f) is the only representation of (22) that explains why (22) does not entail (23). One obtains a satisfactory analysis of sentence (22) in Dowty's framework only because the logical form of (22) may assign both the operator PROG *and* the operator BECOME *wider scope* than the quantifier.

5 Conclusion

In this chapter we have investigated the behaviour of the progressive in sentences containing universally quantified noun phrases. The rule of *universal instantiation* fails with respect to sentence (1): (1) does not entail sentence (2).

- (1) Max was kissing every girl
- (2) Max was kissing Susan

I argued that this cannot be accounted for in Parsons' event-based framework.

Dowty (1979) is able to account for the relationship between (1) and (2) by defining the progressive in terms of inertia worlds. Thus Dowty's Eventual Outcome Strategy in defining the progressive yields an analysis of (1), whereas Parsons' Event-based Strategy does not. But in chapter 3, the Eventual Outcome Strategy was found to be inadequate in other respects. So a puzzle remains: how can one combine the Eventual Outcome Strategy's advantage on the analysis of (1) with an account of the progressive that does not suffer its fatal flaw? In chapter 7, I will offer a definition of the progressive that is *not* based on the Eventual Outcome Strategy but that nevertheless can explain why universal instantiation fails with respect to (1). In the next chapter however, I will present a formulation of the classification of aspect, as a preliminary to giving this definition of

the progressive.

Chapter 6

A Formal Characterisation of Aspectual Taxonomy

1 Introduction

A prerequisite to solving the imperfective paradox is the semantic interpretation of a classification of aspect, and this is the main concern of this chapter. The formal theory offered will rely on two different tools. The first is a temporal logic developed by Richards and known as IQ (Richards 1986). The second is an AI model of temporal reference that has been developed by Moens and Steedman (Moens and Steedman 1987, Moens 1987).

The formal semantic characterisation of aspectual taxonomy presented here will be used in the next chapter to solve the imperfective paradox. However, this chapter is concerned solely with setting up the semantic analysis of aspectual taxonomy; it is not concerned with the virtues of the resulting theory.

2 The Classification of Aspect

Moens provides a taxonomy of aspect containing five categories. He distinguishes between the category of *states* (cf. "know", "understand") which correspond to Vendler's (1967) states, and the other four categories which are classified as belonging to the genus of events.

In the genus of events, there is a distinction between events that are extended and those that are not, corresponding to Vendler's (1967) distinction between events that constitute processes and events that do not. There is also a distinction between events that have a definite 'goal' or 'conclusion' and events that do not. Thus Moens distinguishes among four types of events: *processes* (cf. "run", "swim") are extended events that do not have a 'conclusion' and they correspond to Vendler's activities; *culminated processes* (cf. "build a house", "eat a sandwich") are extended events that do have a 'conclusion' and they correspond to Vendler's accomplishments; *culminations* (cf. "win the race", "reach the summit") are 'punctual' events that have a 'conclusion' and they correspond to Vendler's achievements; and *points* (cf. "wink", "tap"), are 'punctual' events that do not have a 'conclusion', and they do not have a corresponding category in Vendler's classification.

Moens argues that *linguistic context* determines the aspectual class of expressions. To find where an expression rests with the classification, one investigates what adverbials it can co-occur

with, what changes of meaning occur when it appears with certain tense and aspect markers, and so on. For example, it is assumed that the "for"-adverbial "for four minutes" qualifies only expressions that denote processes, and the "in"-adverbial "in four minutes" qualifies only expressions that denote culminated processes. So "Max ran" is classified as a process, because it combines with the "for"-adverbial "for four minutes" felicitously, as in sentence (1).

(1) Max ran for four minutes

However, "Max ran" may be classified as a culminated process, because sentence (2) is felicitous in a situation where Max runs a fixed distance every morning.

(2) Max ran in four minutes (this morning)

To account for sentence (2), Moens does not conclude that the expression "Max ran" is ambiguous between a process and culminated process. Instead, he attempts to describe the phenomenon by stipulating that "Max ran" is basically a process that can move from one category to the other provided the context is such as to make these transitions felicitous.

It is not clear from a formal perspective what transitions are. We will propose a slightly different view to Moens' on the classification of aspect. We will view the expression "Max ran" as *ambiguous*, and we will use the process sense of "Max ran" to *define* the culminated process sense of "Max ran". Our formalism will reflect Moens' claim that *linguistic context* determines the aspectual class of an expression as it appears in a particular utterance. For example, our formalism will yield an analysis of sentence (2) where it is false unless "Max ran" as it appears in (2) denotes a culminated process. But unlike Moens, we will view the linguistic context as *disambiguating* the aspectual class of the expression, rather than determining which 'transitions' between the aspectual classes took place.

We propose that "Max ran" refers to a culminated process in (2). We now have the task of characterising that culminated process. A culminated process is a process that leads to a culmination. So the culminated process "Max ran" must be identified in terms of, among other things, the appropriate culmination. Moens claims that the culminated process "Max ran" has a context-sensitive element to it, because the appropriate *culmination* is determined by *extra-linguistic context*. For example, if Max runs the distance of a mile every morning, then we intuitively interpret (2) to mean that it took Max four minutes to run the distance of one mile, and in this case, the suitable culmination is Max reaching the distance of one mile. Alternatively, if Max runs the distance

of two miles every morning, then we intuitively interpret (2) to mean that it took Max four minutes to run the distance of two miles, and in this case, the suitable culmination is Max reaching the distance of two miles. There are, of course, many alternatives to these.

We propose to define the culminated process sense of "Max ran" in terms of the process sense of "Max ran", plus some appropriate *culmination* which will be determined by *extra-linguistic context*. This reflects Moens' observation that extra-linguistic context determines what culminated process "Max ran" refers to in an utterance of (2). So we are introducing here two different notions of context. The *linguistic context* disambiguates the aspectual classification of "Max ran" as it appears in particular utterances. The *extra-linguistic context* establishes exactly what culminated process "Max ran" refers to in an utterance of (2), e.g. it determines whether the culminated process is Max running one mile, or Max running two miles, etc.

So to conclude, we intend to characterise the culminated process sense of "Max ran" in terms of an *operator* that operates on the process sense of "Max ran", and this operator will involve reference to a culmination which is picked according to extra-linguistic context.

3 The Formulation of the Classification of Aspect

3.1 What Should the Formalism Look Like?

What apparatus is required to formulate the aspectual taxonomy described above? We will view the classification of aspect as a classification of *propositions* (and the way we view propositions will be formally defined below). Suppose one aims to distinguish among the five aspectual categories on the grounds of *semantics*. Then the classification of aspect is a classification of *propositions* that divides the set into at least five classes, corresponding to the five aspectual categories: state propositions, process propositions, culmination propositions, culminated process propositions and point propositions.

As we've just mentioned, we intend to characterise the culminated process sense of "Max ran" as it appears in sentence (2) in terms of an operator that operates on the process sense of "Max ran", and this operator will also involve reference to a culmination, where the culmination is picked according to extra-linguistic context.

(2) Max ran in four minutes

In order to formulate this in a logical environment we must achieve two tasks; we must identify the

culmination proposition according to the context of utterance of (2) and we must characterise the operator that operates on the the process sense of "Max ran" (where the process sense of "Max ran" denotes a process proposition).

Given that the operator will operate on process sentences (i.e. sentences that denote process propositions) but will also involve reference to a culmination proposition, we will give the operator a complex syntactic structure. It will be represented as a complex operator CP_b ("CP" is glossed as "culminated process"), where b is a referring expression that denotes a culmination proposition. So the culminated process sense of "Max ran" will be represented as a sentence of the form $CP_b(A)$, where CP_b is a complex operator, b is a referring expression that denotes a culmination proposition, and A is a sentence which denotes a process proposition.

Suppose that the formula $run(max)$ (where "run" is a one-place predicate and "max" is a constant) unambiguously denotes a process proposition in the theory. Then $run(max)$ represents the process sense of "Max ran", and so the culminated process sense of "Max ran" in sentence (2) must be represented in the formalism by the formula $CP_b(run(max))$ for some appropriate culmination proposition denoted by the referring expression b (i.e. this formula will be embedded in the logical form of (2)). We now have the task of specifying the culmination proposition denoted by b in the logical form of (2).

We have argued that this culmination is *not* identifiable independently of extra-linguistic context. Indeed, the context of utterance of (2) will determine whether there is a suitable culmination at all (and if there is not, then sentence (2) is anomalous with respect to that particular context). In particular, the context of utterance of (2) may determine the suitable culmination as Max reaching the distance of one mile, or Max reaching two miles, etc. To reflect this in the formal theory, the semantics of the formula $CP_b(run(max))$ that represents (2) must be such that the value of the culmination proposition denoted by b is identified by the context of utterance of (2). But how may the semantics of the formula $CP_b(run(max))$ that represents (2) be defined so as to refer to a proposition denoted by b whose value is determined by context? How may the logical analysis of sentences of the form $CP_b(A)$ refer to context?

The preceding discussion concerning sentence (2) suggests that in some cases the relation of a sentence to its context of utterance may be a matter of logical form. So one must pick a framework that appreciates the role of context in truth definitions. I suggest that IQ is such a framework.

3.2 An Informal Introduction to IQ

IQ is an interval-based framework originally designed to provide a formal semantic treatment of tense and temporal quantification in English (Richards 1986). The theory is further developed in (Oberlander 1987a). Propositions are functions from world-interval pairs to truth values; this is why IQ is viewed as an interval-based framework. However, it is only superficially similar to other interval-based accounts, such as Dowty's (Dowty 1979). Intervals are treated differently in Dowty's theory, making it difficult to compare Richards' theory to it. In particular, the framework of IQ maintains a notion of *homogeneity* whose nature we will define below, and this notion of homogeneity has no status in Dowty's representation of natural language (cf. chapter 2).

IQ offers a technique whereby temporal expressions can have representations that achieve their semantic interpretation with respect to *context*. This is achieved by invoking in the object language of IQ a set of referring expressions known as *parameters* which refer in virtue of *context*: a possibly partial function g_c , which is part of the model, assigns values to the parameters relative to the context c . So any expression in the object language that invokes a parameter receives its semantic interpretation with respect to context, for its semantic value will depend on the denotation of the parameter assigned by the function g_c for the context c .

How may this help us to specify the culminated process "Max run" as it appears in sentence (2)?

(2) Max ran in four minutes (this morning)

We have argued that the analysis of (2) has embedded in it the formula $CP_b(\text{run}(\text{max}))$ where CP_b is a complex operator that operates on the process sentence $\text{run}(\text{max})$, and b denotes a culmination proposition which is determined by the context of utterance. This idea may be expressed in an *extended version of IQ*, which contains parameters that refer to entities in the domain of *propositions*³⁹. The culminated process "Max run" described in sentence (2) will be denoted by $CP_e(\text{run}(\text{max}))$, where e is a propositional parameter whose value is determined by the function g_c : in the truth definition of $CP_e(\text{run}(\text{max}))$ to be defined below, the value of $g_c(e)$ will be the suitable culmination proposition given the context c of utterance.

³⁹ An extended version of IQ, that includes the set of constants, variables and parameters ranging over propositions, is used by Richards (1987) to account for *temporal connection*.

When we define the truth conditions of $CP_e(A)$, we will see that CP_e is an operator modulo e ; it is multiply ambiguous because of the different possible values assigned to e .

4 The Syntax and Semantics of the Extended Version of IQ

This section concerns the syntax and semantics of the extended version of IQ, as a preliminary to investigating how the taxonomy of aspect that we have described may be expressed in it. But first, it is worth taking a little time to note some of IQ's leading ideas, before proceeding to describe the formal apparatus invoked and its accompanying semantics.

The IQ framework is proposed as part of a formal semantics for a fragment of natural language containing a wide variety of temporal expressions. The language of IQ (henceforward referred to as *Liq*) is an extension of the ordinary predicate calculus, which contains the usual constants, variables, n -place predicates, truth functional connectives and quantifiers. The constants and variables are *sorted* into four domains in the extended version of IQ that we are considering here; they range over individuals, possible worlds, intervals of time and propositions. I stress that this is an extended version of the framework of IQ, where the language has referring expressions that denote propositions. The standard framework of IQ does not invoke any such referring expressions, for in this framework the constants and variables are sorted into the *three* domains of individuals, possible worlds and intervals of time.

Richards (1986) proposes a basic division between tense and temporal quantification. In the former category he includes the three traditional logical tenses, past, present and future; in the latter category he includes adverbs such as "always", "never" and "exactly twice". He argues that the former category involves essential reference to speech time, whereas the latter does not. In this respect, Richards follows Russell for tenses and Prior for temporal quantifiers. *Liq* is designed to reflect this distinction: tenses are deictic sentential operators explicitly representing the Russellian view that tensed utterances are in some sense about the time of speech. In contrast to tense, the quantifiers refer to time, but not necessarily to speech time.

To achieve a deictic analysis of tense, Richards incorporates into *Liq* a set of referring expressions over and above constants and variables. These are *parameters*. Unlike constants and variables, parameters refer in virtue of *context*: a function g_c is part of the model and g_c assigns the parameters their denotations with respect to the context c . The parameters are 'sorted' like the constants and variables, and in the extended version of IQ that we are discussing here they range over the four domains of individuals, worlds, intervals and propositions. Parameters occur in the syntax

of Liq on deictic sentential operators such as tense. They appear as subscripts on the operators: for example the past tensed version of an untensed sentence A (such as $\text{win}(\text{max}, \text{race})$) is represented as $\text{PAST}_{(v,t)}(A)$, where v is a parameter which ranges over the domain of possible worlds, and t is a parameter which ranges over the domain of intervals of time. $\text{PAST}_{(v,t)}(A)$ is true if the following holds:

$\text{PAST}_{(v,t)}(A)$ is true at the world-time index (w,i) if and only if $g_c(v) = w$, $g_c(t) = i$ and there exists an interval j earlier than i such that A is true at (w,j) .

In the above definition the function g_c assigns the parameters v and t the 'place' (i.e. possible world) and time of speech. Thus Richards' analysis of tense is Russellian in that it refers essentially to speech time⁴⁰.

A *model* for Liq is a septuple $\langle D, W, I, E, \leq, g_c, f \rangle$ where the four non-empty sets D , W , I , and E correspond respectively to the domains of individuals, possible worlds, intervals of time and propositions; \leq is a partial ordering relation on the domain I of intervals; g_c is the function that assigns parameters their denotations; and f is the interpretation function which assigns the non-logical constants of Liq their intensions.

The interpretation function f is designed so as to maintain a high degree of *homogeneity*. That is, the truth clauses for the expressions of Liq are such that the definition of truth will yield the following homogeneity property for boolean combinations of atomic formulae of Liq (which I will subsequently define):

An atomic formula (e.g. $\text{win}(\text{max}, \text{race})$, $\text{run}(\text{max})$) is true at an index (w,i) only if for all subintervals j of i the formula is true at (w,j) .

The above homogeneity principle is fundamental to the framework IQ, and sets it apart from other interval-based frameworks, such as (Dowty 1979). As discussed in chapter 2, Dowty (1979) represents the sentence "Max win the race" so that it may be true at an interval i and false at an interval j contained in i . This is not the case for IQ, for the formula representing "Max win the race" (i.e. $\text{win}(\text{max}, \text{race})$ ⁴¹) is subject to the above homogeneity restriction. It must be stressed, however, that the homogeneity restriction will *not* apply to *all* the sentences of the language, but only the boolean combinations of the atomic sentences. The interpretation function f is designed to maintain this notion of homogeneity.

⁴⁰ IQ's tenses are deictic in a limited way; they don't invoke definite reference to (say) past time. cf. Partee (1973) for an alternative view of the deictic nature of tense.

⁴¹ We will view "race" as a term in order to simplify the analysis for our purposes here.

So to summarise, there are basically two leading ideas in IQ. First, there are certain temporal expressions, such as tense, whose semantic interpretations are essentially about the context of utterance. Second, the framework of IQ is designed so as to maintain the above *homogeneity* restriction. Now that the general motivation for Liq is in place, I will give the formal definitions of the syntax and semantics of Liq.

4.1 The Syntax

The basic expressions of Liq are defined below:

- (i) Four countably infinite sets of *variables*: V_D , V_W , V_I , and V_E . For $k \geq 0$ x'_k is a variable in V_D , v'_k is a variable in V_W , t'_k is a variable in V_I , and e'_k is a variable in V_E . We let x' , v' , t' and e' range arbitrarily over these sets.
- (ii) Four (possibly empty) sets of name *constants*: C_D , C_W , C_I , and C_E . For $k \geq 0$ x^*_k is a constant in C_D , v^*_k is a constant in C_W , t^*_k is a constant in C_I , and e^*_k is a constant in C_E . We let x^* , v^* , t^* and e^* range arbitrarily over these sets.
- (iii) Four (possibly empty) sets of *parameters*: P_D , P_W , P_I , and P_E . For $k \geq 0$ x_k is a parameter in P_D , v_k is a parameter in P_W , t_k is a parameter in P_I , and e_k is a parameter in P_E . We let x , v , t and e range arbitrarily over these sets.
- (iv) For $n \geq 0$ a countably infinite set P^n of n -place *predicate constants*. We let R_n be an arbitrary member of P^n .
- (v) *Quantifiers*: \exists , \forall .
We read \exists and \forall as "some" and "all" respectively.
- (vi) The set of D-terms is $V_D \cup C_D \cup P_D$, the set of W-terms is $V_W \cup C_W \cup P_W$, the set of I-terms is $V_I \cup C_I \cup P_I$, and the set of E-terms is $V_E \cup C_E \cup P_E$.
- (vii) *Tense operators*: $PRES_{(v,t)}$, $PAST_{(v,t)}$, $FUT_{(v,t)}$.
We let Π range over the set of tense operators.

The well formed formulas (wff's) of Liq can now be defined inductively in the familiar way.

- (i) Where R_n is an n -place predicate constant and d_1, \dots, d_n are D-terms, $R_n(d_1, \dots, d_n)$ is an atomic wff.
- (ii) Where A is a wff and x belongs to V_D , $\exists xA$ and $\forall xA$ are wff's.
- (iii) If A is a wff and Π is a tense operator, ΠA is a wff.

4.2 The Semantics

Although IQ is an interval-based system, points play an essential role. In effect, the semantics of IQ assumes the notion of a point-structure. A point-structure T is a pair $\langle T, \triangleleft \rangle$ consisting of a nonempty set (of points of time) T which is partially ordered by \triangleleft .

Relative to T , an IQ-structure M is defined as follows: M is a septuple $\langle D, W, I_T, E, \ll, g_c, f \rangle$ such that

- (a) D, W and I_T are disjoint nonempty sets to be understood respectively as the set of possible objects, possible worlds, and intervals of moments of time. The non-empty set E is understood as the set of possible propositions (built from the sets W and I_T). It consists of all functions from $W \times I_T$ to the truth values $\{0, 1, u\}$ ("u" is to be glossed as "undefined"). Where there is no confusion I will abbreviate " I_T " to " I ".
- (b) I_T is a subset of P_T , the power set of T , such that:
 - all singletons in P_T belong to I_T ,
 - i is in I_T only if for all t' and t'' belonging to i if there is a t such that $t' < t < t''$, then t is in i ,
 - \emptyset (the empty set) does not belong to I_T .
- (c) \ll is the partial ordering of I_T induced by T , i.e. for all i and j belonging to I_T $i \ll j$ if and only if for all t in i and t' in j $t < t'$.
- (d) g_c is a function (the "indexical" function) from the parameters of L_{iq} to the corresponding objects.
- (e) f is a function which assigns to the constants of L_{iq} the suitable (possibly partial) intensions from $W \times I_T$.

The interpretation function f is subject to the following *homogeneity* restrictions (these will yield the homogeneity principle described in the previous section):

- (i) For every name constant b^* and predicate r_n , $f(b^*)(w, i)$ and $f(r_n)(w, i)$ are defined for all (w, i) in $W \times I$, where i is a singleton.
- (ii) For all name constants b^* , $f(b^*)(w, i) = f(b^*)(w, j)$ for all j included in i (all subintervals of i).
- (iii) for any predicate constant r_n , $f(r_n)(w, j)$ is included in $f(r_n)(w, i)$ for all subintervals j of i .

Because of the homogeneity restrictions on f , intensions will typically be partial. However, the appropriate valuation space for an IQ-structure is one with three truth-values: 1 ("true"), 0 ("false") and u ("undefined"). A formula will have the value u whenever any of its non-logical constants are undefined. It must be stressed that u is a third truth value rather than a truth value gap.

An atomic sentence $r_n(a_1, \dots, a_n)$ is true in M at (w, i) if the sequence $f(a_1)(w, i), \dots, f(a_n)(w, i)$ belongs to $f(r_n)(w, i)$; it is false at (w, i) if the given sequence does not so belong; and otherwise it is undefined. This interpretation for atomic sentences together with the homogeneity restrictions (i), (ii) and (iii) on f yield the *homogeneity* principle expressed in (3).

- (3) An atomic sentence will be true at an index (w, i) only if for all subintervals j of i , the sentence is true at (w, j) .

The *truth definition* for Liq proceeds in terms of the notion of an *IQ-interpretation* based on an IQ-structure M .

An IQ-interpretation is a pair $\langle M, g \rangle$ such that M is an IQ-structure and g is a function which assigns values to the variables of Liq.

Given an IQ-interpretation, the denotation of a well-formed expression β is defined recursively in the familiar way (we give the definitions in appendix 5). We let $[[\beta]]^{\langle M, g \rangle}(w, i)$ be the denotation of β relative to the IQ-interpretation $\langle M, g \rangle$ with respect to the pair $(w, i) \in W \times I$.

Now that the syntax and semantics of the language of IQ are in place, I will explore how one might implement the suggestions outlined earlier: to formulate the taxonomy of aspect in the framework IQ.

5 The Model Structure

If the distinctions between the five aspectual classes are to be thought of as *semantic* distinctions, then the task ahead is to provide a suitable model structure that captures these distinctions. The set E of propositions, which corresponds to the set of all functions from $W \times I$ to $\{0, 1, u\}$, must be divided into at least five classes corresponding to the five aspectual categories: E must consist of a set S of states, a set Pr of processes, a set Po of points, a set Cu of culminations and a set Cp of culminated processes. One must distinguish among the functions from these five classes of E . How may this be done?

First, let us consider what restrictions we require on the set Po of points. There is a reading of the sentence "Max winked (once)" where the event referred to is 'punctual'; it does not extend in time. This is the point sense of "Max winked", and to reflect the idea that points are *punctual* events, one might assume that propositions from Po have what I call *moment structures*. That is, a point proposition must return the value "true" only at minimal intervals, or, in other words, moments (a moment in IQ is an interval that is a singleton set).

Given the *homogeneity principle*, however, this must also be true of the set Cu of culminations and Cp of culminated processes. For suppose that an atomic untensed sentence A denoting a culmination (or culminated process) proposition is true at an extended interval i , however small. Then by homogeneity A is true at every subinterval of i . One is now committed to one of two undesirable consequences. The first alternative is that the structural representation of A is not related to the 'goal' or 'conclusion' of the culmination (or culminated process) it denotes. The second alternative is that A has a 'goal' or 'conclusion' associated with it, but homogeneity

establishes that this conclusion occurs at every interval contained in i (since A is true at every interval contained in i). Hence a homogeneous interpretation of culminations and culminated processes is satisfactory only if they are true only at *minimal* intervals, or, in other words, moments (which are the singleton sets). Under this restriction, the structural representation of A can talk about a 'goal' or 'conclusion', which will occur at the moment at which A is true.

Since as a result of homogeneity the propositions in the set Cu of culminations and the set Cp of culminated processes must be moment-structures, and in addition, the propositions in the set Po of points are also moment-structures, it is difficult to see how one may account for a distinction between these three classes of propositions, and so a *semantic* distinction between points, culminations and culminated processes is not sustainable in IQ.

The fact that IQ is homogeneous entails that one must drop the assumption that there are semantic distinctions between points, culminations and culminated processes. At this point one may decide that since IQ cannot sustain a semantic distinction between these three aspectual classes, it is not a suitable framework for formulating a classification of aspect. Alternatively, one may decide that a semantic distinction among points, culminations and culminated processes is not necessary⁴². It is the latter option that we choose.

It is important to realise that following this course does not undermine the logical form we proposed for sentence (2).

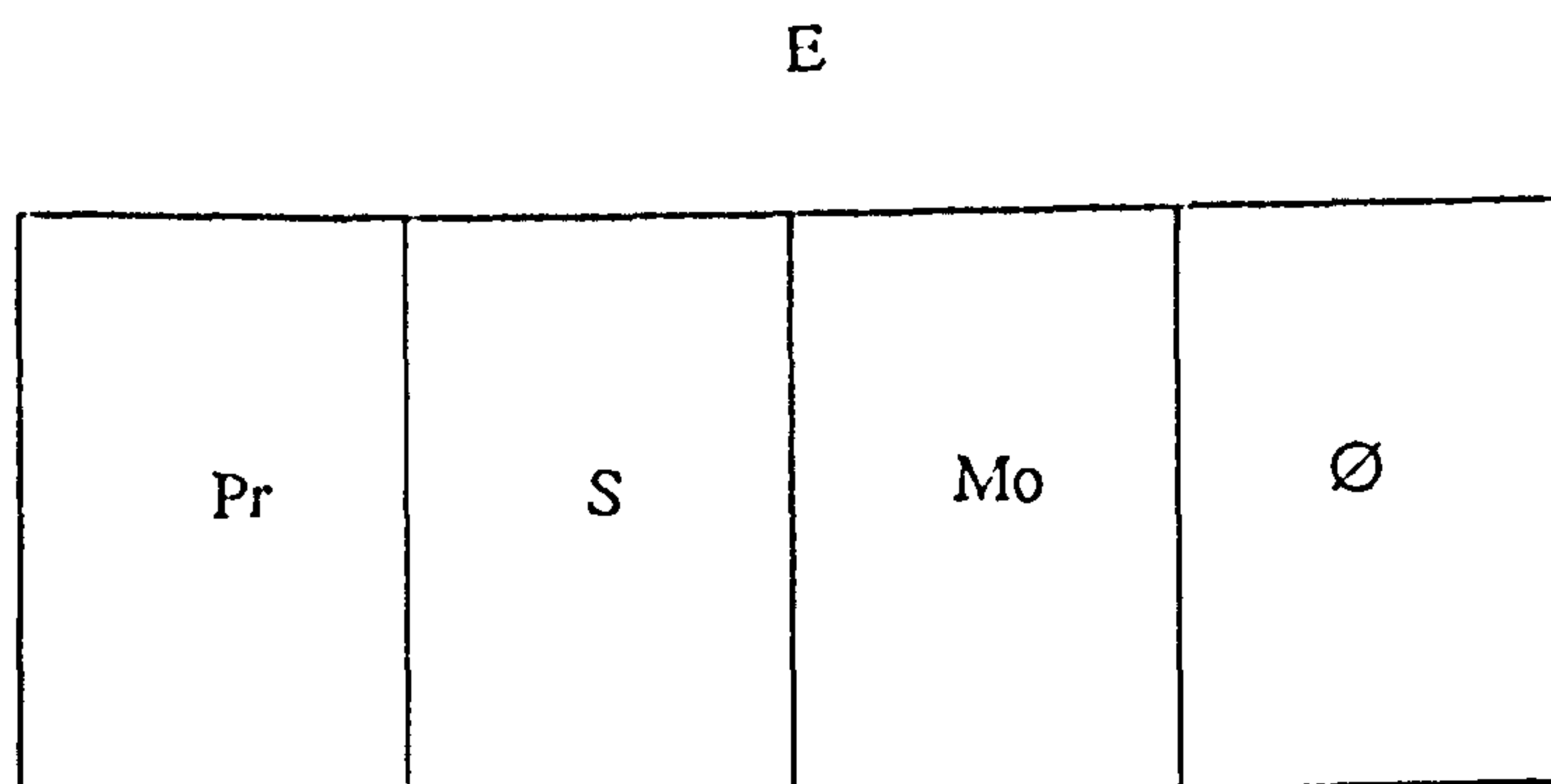
(2) Max ran in four minutes (this morning)

We have proposed that "Max ran" as it appears in (2) is represented by the formula $CP_e(\text{run}(\text{max}))$, and we will define $CP_e(\text{run}(\text{max}))$ so that it denotes a proposition of the right sort, namely a moment structure. We will subsequently show how this is done.

Although there are no semantic distinctions between points, culminations and culminated processes, we will account for semantic distinctions between processes, states and the set {points, culminations, culminated processes}. The set E is *partitioned* into *four* classes; Pr denoting processes, S denoting states, Mo denoting moment-structures corresponding to the set of points, culminations and culminated processes, and \emptyset denoting the remaining functions in E . E can be

⁴² This certainly wouldn't be the first theory to group points, culminations and culminated processes into the same aspectual class. Parsons (1984) groups them together in the class of *events*, and Bennett (1981) groups them together in the class of *telic events*.

represented diagrammatically as follows:



The conditions placed on the members from these classes are as follows:

Condition on Pr

$pr \in Pr$ if and only if for all indices $(w,i) \in W \times I$, if $pr(w,i) = 1$ and if for all intervals j such that i is contained in j $pr(w,j) = 0$, then i is a closed non-minimal interval.

By the above condition, if $pr \in Pr$, then it has what I call a *closed interval* structure. That is, the function pr may be true on an open interval, but any such interval is surrounded by a non-minimal closed interval at which pr is true. Similarly, any minimal interval at which pr is true is surrounded by a non-minimal closed interval at which pr is true. Placing this condition on the set Pr of processes reflects in the formalism Moens' idea that processes have definite endpoints and essentially extend in time. Hence the function pr may be pictorially represented as below, where the square brackets denote bound intervals and pr is true at every subinterval of those bound intervals (by homogeneity).

[-----]
pr = 1

The propositions in the set S of states must satisfy the following condition:

Condition on S

$s \in S$ if and only if for all $(w,i) \in W \times I$, if $s(w,i) = 1$ and if for all intervals j such that i is contained in j $s(w,j) = 0$, then i is open.

So if $s \in S$, then it has what I call an *open interval* structure. That is, the function s may be true on a closed interval, but any such interval is surrounded by an open interval at which s is true. Hence it produces the following temporal structure, where the curved brackets represent unbound intervals, and s is true at every subinterval of those unbound intervals (by homogeneity).

$$\begin{array}{c} \text{-----} \\ s = 1 \end{array}$$

The fact that the members of the set S of states all have open interval structures in our theory reflects Moens' idea that states do not have definite endpoints.

The propositions in the set Mo , which corresponds to the set of points, culminations and culminated processes grouped together in one class, have to satisfy the following condition:

Condition on Mo

$mo \in Mo$ if and only if for all $(w,i) \in W \times I$ such that $mo(w,i) = 1$, i is a *moment*.

If $mo \in Mo$, then it is a *moment-structure*. That is, the function mo is true only at moments (or, in other words, minimal intervals, which are the singleton sets). Hence it produces the following temporal structure, where " \square " represents a minimal interval.

$$\begin{array}{c} \square \\ mo = 1 \end{array}$$

The fact that the members of Mo are moment-structures reflects the idea that points are 'punctual', and it also reflects the idea that the 'conclusion' associated with a culmination or culminated process is punctual (for it happens at the moment at which the culmination or culminated process is true).

The reader should bear in mind that when we now talk of points, culminations and culminated processes, we are *not* talking of semantically distinct entities, but instead we are using these terms as terms of art; we simply use them to talk about sentences that denote the same sort of propositions, namely moment structures. We have been limited to this interpretation of culminations and culminated processes by the homogeneity principle that is part of the framework IQ. It must be stressed that we will not even distinguish among the *logical forms* of the sentences that Moens classifies as culminated processes, the sentences he classifies as culminations, and the sentences he classifies as points. However, we will not drop the terms "points", "culminations" and "culminated processes" altogether in this chapter because they will enable the reader to see what intuitions motivate the formal theory, even though these terms do not have any formal status.

The functions that are in the set \emptyset satisfy the following condition:

Condition on \emptyset

$e \in \emptyset$ if and only if none of the conditions on Pr , S or Mo hold.

So the largest connected intervals at which a function $e \in \emptyset$ returns the value "true" are open

intervals, closed intervals and moments, and can be represented pictorially as follows:

$$\begin{array}{ccc} (-----) & [-----] & \square \\ e = 1 & e = 1 & e = 1 \end{array}$$

The set of functions \emptyset does not correspond to any of the aspectual categories, but is included as a subclass of E since E contains *all* possible functions from $W \times I$ to $\{0,1,u\}$.

6 The Semantics of the Aspectual Operators

6.1 CP

Given the above model structure, how is one to interpret the classification of aspect? Our objective is to substantiate from a formal perspective the suggestions made in section 3 concerning the semantic interpretation of aspectual taxonomy. Consider once again sentence (2).

(2) Max ran in four minutes (this morning)

The suggestion we made in section 3 is that "Max ran" as it appears in (2) is a culminated process, which is to be defined in terms of the process sense of "Max ran" plus some culmination determined by extra-linguistic context. To capture this in the formalism, we proposed that the analysis of (2) has embedded in it the sentence (4) that denotes the culminated process sense of "Max run"⁴³.

(4) $CP_e(\text{run}(\text{max}))$

CP_e is an operator modulo e where the proposition $g_e(e)$ will be the culmination determined by the context c , and $\text{run}(\text{max})$ is the representation of the process sense of "Max run". The semantic value of (4) will be a proposition in Mo (and therefore it will be a proposition of the right sort since culminated process sentences must denote propositions in Mo).

The puzzle is that since we wish $g_e(e)$ to be the culmination of the process of Max running, it cannot be chosen in an ad hoc manner. We must somehow restrict our choice of $g_e(e)$ to propositions of the appropriate sort. $g_e(e)$ cannot, for example, be the proposition that Max has slept for a week, because, as outlined by Moens, the process of Max running and its culmination must be

⁴³ The full analysis of sentence (2), that incorporates the representation of the adverbial "in four minutes", will be given in the next chapter.

'causally' related.

That is, the culmination $g_c(e)$ must have been the *result* of the process of Max's running that was going on before it. In other words, *whenever* $g_c(e)$ is true, the process of Max's running, i.e. $\text{run}(\text{max})$, must have been true just before.

This sheds some light on the relationship in IQ that we require between the proposition $g_c(e)$ and the process proposition denoted by $\text{run}(\text{max})$ in our truth conditions for (4). Suppose we define a relation R_1 as below:

Relation R_1

The process pr stands in relation R_1 to the moment-structure mo if for all indices $(w', i') \in W \times I$, if $\text{mo}(w', i') = 1$ then there is some interval j' such that i' is the final bound of j' and $\text{pr}(w', j') = 1$.

(So whenever mo is true, the process pr goes on just before).

Then in the semantics of (4), we require the process denoted by $\text{run}(\text{max})$ to stand in the relation R_1 to the moment-structure $g_c(e)$. i.e. for any world w and moment m , if $g_c(e)$ is true at (w, m) , then there must be some interval i of which m is the final bound and the process $\text{run}(\text{max})$ is true at (w, i) (so whenever $g_c(e)$ is true, the process goes on at some interval just before). Note that R_1 expresses a *necessary* relation, for it must hold for every world-time index.

If the semantics of (4) invokes this relation between $g_c(e)$ and $\text{run}(\text{max})$ then our choice of $g_c(e)$ is essentially restricted in the way we want. In a model M that reflects the intuition that there is no relation between Max's running and his sleeping, we cannot pick $g_c(e)$ as Max has slept for a week. This is because in the model M the process denoted by $\text{run}(\text{max})$ will *not* stand in the relation R_1 to the proposition that Max has slept for a week for there is some index (w', i') such that Max has slept for a week is true in M at (w', i') but $\text{run}(\text{max})$ is false in M at (w', j') for all the intervals j' whose final bound is i' .

This relation R_1 between the process proposition and the proposition $g_c(e)$ is captured in the following truth definition of $\text{CP}_e(A)$ for the sentence A :

$\text{CP}_e(A)$ is true in a model M at (w, i) if

- (a) the proposition denoted by A , (which is referred to as $\llbracket A \rrbracket^{<M, g>}$) is a member of Pr , and $g_c(e)$ is a member of Mo , and
- (b) for every possible world w' and for every interval of time i' , if $g_c(e)(w', i') = 1$ then there is an interval j' such that i' is the final bound of j' and $\llbracket A \rrbracket^{<M, g>}(w', j') = 1$, and
- (c) $g_c(e)(w, i) = 1$ (so by condition (b) there is an interval j such that i is the final bound of j and A is true at (w, j));

it is false if any of conditions (a), (b) or (c) do not hold;

and otherwise it is undefined.

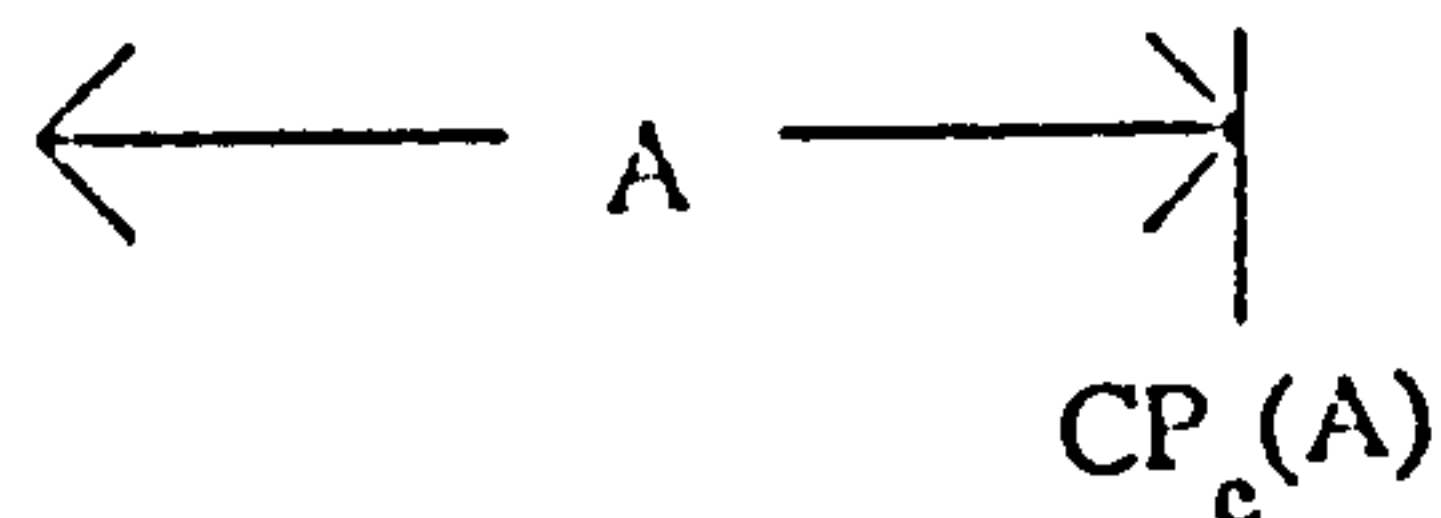
"CP_e" is an operator modulo e: it is multiply ambiguous because of the different possible values assigned to e.

Let us discuss the semantic roles of conditions (a), (b) and (c) in the above definition of CP_e(A). Condition (a) restricts the sort of propositions that A and e can denote. Sentence A must denote a process and g_e(e) must be a member of the set Mo of moment-structures. Thus CP_e(A) is about a *process* (i.e. A) and a *moment-structure* (i.e. g_e(e)), which is as required.

Furthermore, by condition (c) any proposition denoted by the formula CP_e(A) must be a member of Mo, for CP_e(A) is true at the index (w,i) only if, among other things, g_e(e)(w,i) = 1. But g_e(e) ∈ Mo, and so i must be a moment. Hence CP_e(A) can be true at (w,i) only if i is a moment, and so the proposition denoted by CP_e(A) is a member of Mo. Hence the proposition denoted by CP_e(A) is of the right sort (because, as we argued, culminated process sentences must denote propositions that are true only at moments).

But what is the relation between the process proposition denoted by A and the moment-structure g_e(e) defined by the conditions (b) and (c)? Condition (b) corresponds to the relation R₁ that we defined above: it expresses a *necessary* relation between g_e(e) and A, for it is a relation that must be true of *every possible world* and *every interval of time*. It expresses the condition that for any index (w',i'), if g_e(e)(w',i') = 1 then [A]^{<M,g>}(w',j') = 1 for some interval j' of which i' is the final bound (so the truth of g_e(e) must always be immediately preceded by the truth of the process A at some interval). The result of this condition is essentially to restrict our possible choices for the proposition g_e(e). For example in the case of (4), if the model M reflects the intuition that there is no relation between Max's running and his sleeping, then the proposition g_e(e) cannot be that Max has slept for a week because as we explained before, this will not satisfy condition (b). The relation between g_e(e) and A expressed in condition (b) captures the intuition that g_e(e) is some appropriate culmination to A, for there is some necessary (and in fact, 'causal',) relation between them. Hence CP_e(A) is about the process denoted by A and the culmination to the process denoted by A which is determined by extra-linguistic context (i.e. g_e(e)): this is just as we require.

According to condition (c), CP_e(A) is true at (w,i) only if g_e(e)(w,i) = 1, and by the requirements of condition (b), this entails that there is some interval j such that i is the final bound of j and A is true at (w,j). So CP_e(A) is true at (w,i) only if the process A leads to g_e(e) at (w,i). i.e. CP_e(A) has the following temporal structure:



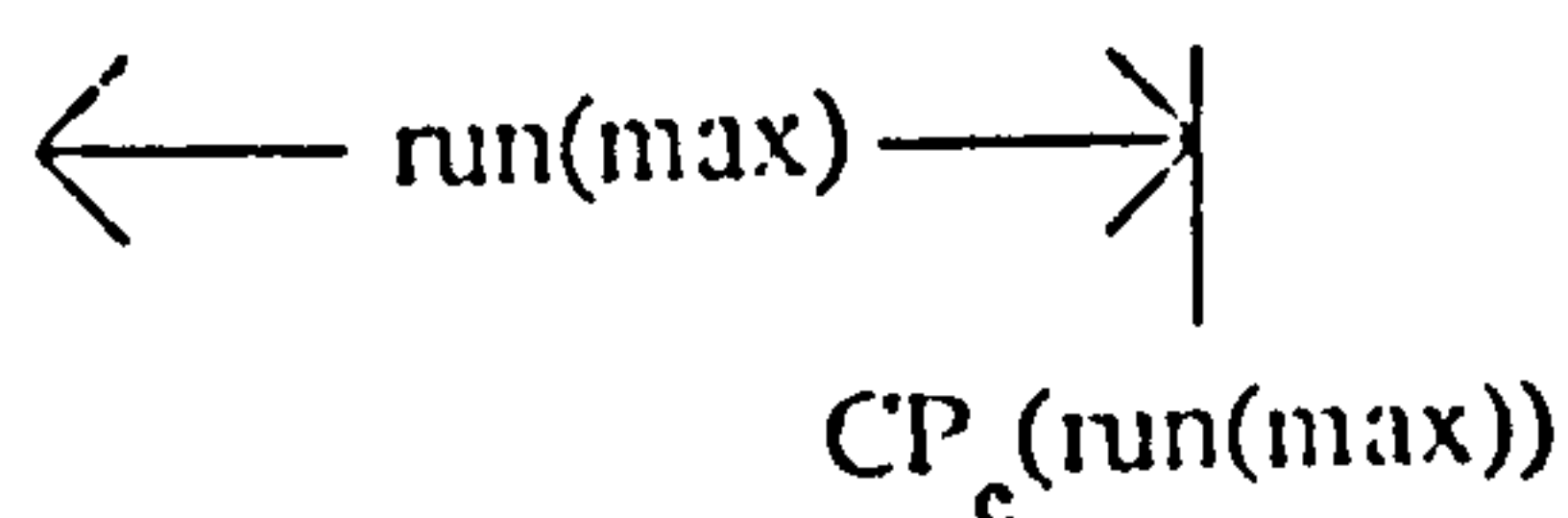
Let us now unravel the truth conditions of sentence (2). The analysis of (2) has embedded in it the formula (4) (the full analysis of (2) that incorporates the representation of "in four minutes" will be given in the next chapter).

$$(4) \quad \text{CP}_e(\text{run}(\text{max}))$$

To interpret (4), one must find a suitable value for $g_e(e)$. Suppose that sentence (2) is uttered as part of the discourse (5).

- (5) (a) Max runs a mile every morning
 (b) Max ran in four minutes (this morning)

Then given the context, a suitable candidate for $g_e(e)$ is the proposition that Max completes the running of one mile⁴⁴. The truth conditions of (4) are then just as required. Certainly condition (a) is satisfied, because $\text{run}(\text{max})$ denotes a proposition from Pr , and $g_e(e)$ is a proposition from Mo . Condition (b) is also satisfied; in order to reflect the intuition that for Max to complete running one mile he must have been running just beforehand, the model M must be such that if $g_e(e)(w', i') = 1$, then $\llbracket \text{run}(\text{max}) \rrbracket^{<M, g>}(w', j') = 1$ for some interval j' whose final bound is i' . Furthermore by condition (c), the truth of (4) at the index (w, i) requires that $g_e(e)(w, i) = 1$, and so by condition (b), $\text{run}(\text{max})$ is true at (w, j) for some interval j whose final bound is i . This can be represented pictorially as below:



⁴⁴ How this reference for $g_e(e)$ is achieved is not a matter we shall consider here. However, note that the proposition $g_e(e)$ will be referred to in the object language by a sentence that has a logical form distinct from (4). If $g_e(e)$ is the proposition that Max completes the running of one mile, then we will assume that $g_e(e)$ is referred to in the object language by the sentence $[\text{DISTANCE-of-one-mile}(\text{run})](\text{max})$, where $\text{DISTANCE-of-one-mile}$ is a function symbol that modifies predicates. We will not consider here how $\text{DISTANCE-of-one-mile}$ would be defined.

The sentence (4) refers to a proposition from Mo, but its interpretation also offers information about what goes on just before it is true. The information is that the process sentence $\text{run}(\text{max})$ is true just beforehand.

6.2 PR

Moens categorises the sentence "Max built a house" as a culminated process, for we naturally interpret it as denoting a process that leads to a culmination. To reflect this in IQ, the formula $\text{build}(\text{max}, \text{house})$ will refer to a proposition from Mo and therefore it will be true only at moments - one can think of the moment at which $\text{build}(\text{max}, \text{house})$ is true as the time when the house is completed - so the logical form of "Max built a house" will be $\text{PAST}_{(v,t)}(\text{build}(\text{max}, \text{house}))$.

Moens argues for the intuition that the progressive aspect qualifies only *process* propositions. For example from an intuitive point of view, (6) asserts that the *process* of building a house is going on, without asserting that the culmination point occurs.

(6) Max was building a house

We will reflect this in our theory by viewing sentence (6) as talking about the process sense of "Max build a house".

Our aim is to define the process sense of "Max build a house" in terms of the culminated process sense of "Max build a house" which is represented in the theory by the formula $\text{build}(\text{max}, \text{house})$. This formula refers to a proposition that is true only at moments. The puzzle is to relate the *extended intervals* at which the process sense of "Max build a house" is true to the *moments* at which the culminated process $\text{build}(\text{max}, \text{house})$ is true.

We described in the previous section the relation that must hold between a culminated process and its corresponding process, and that relation is stated in R_1 . That is, the process pr of Max building a house must stand in the relation R_1 to the proposition denoted by $\text{build}(\text{max}, \text{house})$ so that, as we explained in the previous section, our theory will reflect the intuition that the completion of the house was the result of some building process that was going on before.

But the relation R_1 will not uniquely specify the proposition pr that is the process of building a house. There are many distinct propositions in Pr that will satisfy the relation R_1 to the proposition mo denoted by $\text{build}(\text{max}, \text{house})$. This is because R_1 does not stipulate *how far* the process *extends* back from the time when the house is completed, nor does it specify at the indices where

mo is false whether the process pr is true. For example, suppose that we define the process $pr \in Pr$ so that if $mo(w', i') = 1$, then $pr(w', j') = 1$ on the interval j' whose final bound is i' where j' is *two* years in length. Then pr stands in the relation R_1 to mo . We may also define $pr' \in Pr$ so that if $mo(w', i') = 1$, then $pr'(w', k') = 1$ on the interval k' whose final bound is i' where k' is *three* years in length. Then pr' also stands in the relation R_1 to mo , but pr' is distinct from pr .

So which is the process of Max building a house? We will propose that the process (6) refers to is *not* uniquely specified independently of its *context* of utterance. *Extra-linguistic context* will determine the process that (6) refers to, but the semantics for (6) will be such that the possible choice for this process is subject to the restriction that it must satisfy the necessary relation R_1 to the function mo that is denoted by $build(max, house)$. Since context determines the suitable process of Max building a house, I will represent the process sense of "Max build the house" so that it refers deictically to the process proposition. Hence, we intend to define the process sense of "Max build a house" in terms of the culminated process sense of "Max build a house" (i.e. the formula $build(max, house)$), and this definition must also invoke deictic reference to a process proposition. So the process sense of "Max build a house" will be represented by the formula $PR_e(build(max, house))$ ("PR" is to be glossed as a process), where the value assigned to $g_e(e)$ will be the suitable process of building a house that is determined by extra-linguistic context, and the truth conditions of $PR_e(build(max, house))$ will be defined so that whatever the value of $g_e(e)$, it must satisfy the necessary relation R_1 with the proposition mo that is denoted by $build(max, house)$.

Since $g_e(e)$ must satisfy the necessary relation R_1 with the proposition mo denoted by $build(max, house)$, g_e will *never* determine the process e refers to as the process "John swim", for example, as long as the model reflects the intuition that there is *no* necessary relation between John swimming and Max building a house. But g_e will determine whether or not the process of Max spending money on building materials is the process referred to by e . In the context where Max is spending money on house-building materials with every intention of building a house, (6) will be true, and Max spending money on house-building materials will be the process referred to by e . But in the context where Max is spending money on house-building materials with no intention of building a house, (6) will be false, and Max spending money on house-building materials will *not* be the process referred to by e .

PR_e is defined as follows:

$PR_e(A)$ is true in a model M at (w, i) if

- (a) the proposition denoted by A (which we refer to as $[A]^{<M, g>}$) is a member of Mo , and $g_e(e)$ is a member of Pr , and

- (b) for all indices $(w', i') \in W \times I$, if $\llbracket A \rrbracket^{M, g}(w', i') = 1$ then there is an interval j' whose final bound is i' and $g_c(e)(w', j') = 1$, and
(c) $g_c(e)(w, i) = 1$;

it is false if either conditions (a), (b) or (c) do not hold;
and otherwise it is undefined.

Let us discuss the semantic roles of the conditions (a), (b) and (c) in the above definition. Condition (a) ensures that $PR_e(A)$ is false when the proposition denoted by A is not a member of Mo or the proposition $g_c(e)$ is not a member of Pr , because condition (a) must be satisfied if $PR_e(A)$ returns the value "true". Hence the operator PR_e operates on a *moment-structure* sentence, and it also invokes reference to a *process* whose value is determined by context, which is as required.

Condition (b) states that the process $g_c(e)$ and the moment structure denoted by A are related by the necessary relation R_1 . For any index (w', i') , if A is true at (w', i') , then $g_c(e)$ must be true at some interval just beforehand. The result of condition (b) is effectively to restrict our possible choices for $g_c(e)$. It captures the intuition that the truth of A must be the *result* of the process $g_c(e)$ that was going on just beforehand.

According to condition (c), $PR_e(A)$ is true at (w, i) only if $g_c(e)(w, i) = 1$. It is important to note that $PR_e(A)$ is defined in terms of, among other things, the sentence A , but the truth of $PR_e(A)$ at (w, i) does not entail the truth of A at any time. This reflects the intuition that the process sense of A may go on without the 'conclusion' ever being reached. Our ability to formulate this intuition in IQ will prove important when it comes to solving the imperfective paradox in the next chapter.

Furthermore, by conditions (a), (b) and (c), we can show that the sentence $PR_e(A)$ denotes a proposition from Pr . For suppose that $PR_e(A)$ is true at the index (w, i) . Then by condition (a) $g_c(e) \in Pr$ and by condition (c) $g_c(e)$ is true at (w, i) . So by the properties of propositions in Pr , either i is a non-minimal closed interval, or i is contained in a non-minimal closed interval j such that $g_c(e)$ is true at (w, j) . But given that $PR_e(A)$ is true at (w, i) , conditions (a) and (b) are satisfied for the evaluation of $PR_e(A)$ at (w, j) (because these conditions are independent of the index of evaluation), so if $g_c(e)$ is true at (w, j) , then by condition (c) so is $PR_e(A)$. Hence if $PR_e(A)$ is true at (w, i) then either i is a non-minimal closed interval or i is contained in a non-minimal closed interval j such that $PR_e(A)$ is true at (w, j) . Hence the proposition denoted by $PR_e(A)$ satisfies the condition on the set Pr of processes, and so it must be a process. This is just as required: we want $PR_e(A)$ to denote a process since it represents the process sense of the sentence A .

Let us go back to sentence (6).

(6) Max was building a house

The analysis of (6) will have embedded in it the sentence (7) (the full analysis of (6) that incorporates the representation of the progressive will be given in the next chapter).

(7) $PR_e(\text{build}(\text{max}, \text{house}))$

The value of e relative to a context, i.e. $g_e(e)$, is some proposition that is picked out deictically⁴⁵.

The choice of $g_e(e)$ - e.g. whether it is the process pr corresponding to Max preparing to build the house as well as building it, or the process pr' corresponding only to the action of building - determines which process is said to be in progress when we utter (6). Note that sentence (7) is true at (w, i) only if $g_e(e)$ is true at (w, i) , but it does not assert that $\text{build}(\text{max}, \text{house})$ is ever true.

6.3 INC

We will now introduce an aspectual operator INC that operates on processes to identify the moments at which the process starts. The introduction of this operator will be motivated by the analysis of sentence (8).

(8) Max ran at 3pm

The point adverbial "At 3pm" is currently represented in IQ as a sentential operator whose definition is as follows:

$AT3pm(A)$ is true at (w, i) if and only if A is true at (w, i) and i is 3pm; it is false if either A is false at (w, i) or i is not 3pm, and otherwise it is undefined.

This raises a puzzle concerning sentence (8). The natural interpretation of (8) is an inchoative one; (8) is true only if 3pm is the time at which Max *starts* to run. Assuming the logical form of (8) is (8a), the above truth conditions for "AT3pm" do not capture (8)'s inchoative interpretation.

(8a) $PAST_{(v, t)}[AT3pm(\text{run}(\text{max}))]$

(8a) may be true if Max starts to run at 2pm rather than 3pm. To see this, suppose that $\text{run}(\text{max})$ is true on the interval of time stretching from 2pm to 4pm (i.e. the interval $(2pm, 4pm)$); this indicates

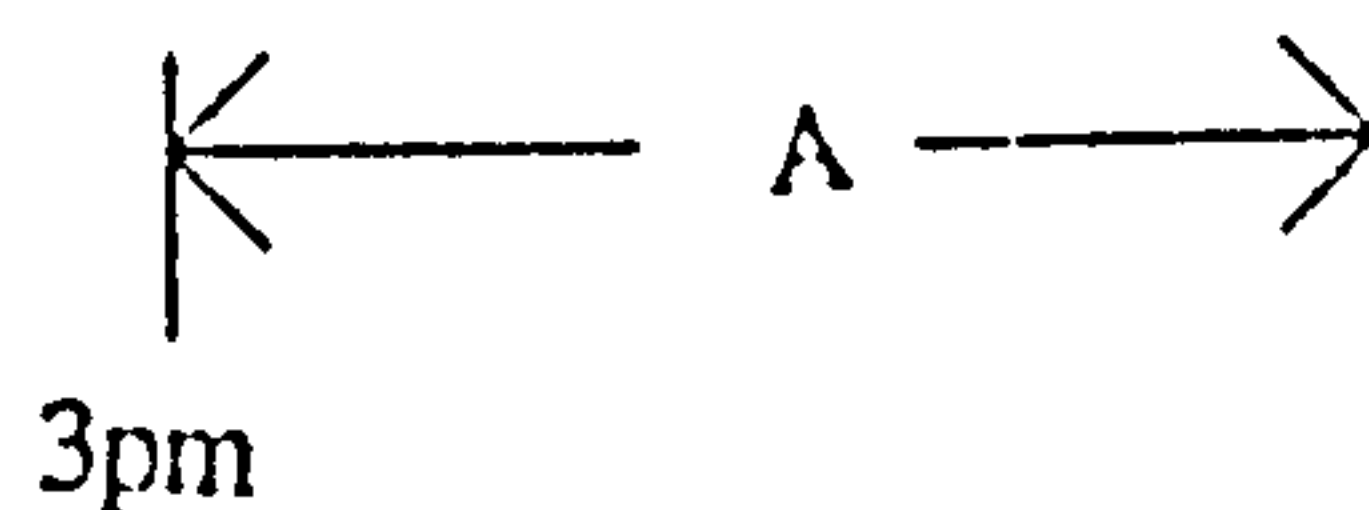
⁴⁵ How this reference is achieved is not a matter we shall discuss here.

that Max started to run at 2pm and finished at 4pm. 3pm is contained in the interval (2pm,4pm), and so by homogeneity, $\text{run}(\text{max})$ is true at 3pm. So by the above truth conditions for "AT3pm", $\text{AT3pm}(\text{run}(\text{max}))$ is true at 3pm, and so by the truth conditions of $\text{PAST}_{(v,t)}$, (8a) is true at some index (w,i) such that 3pm is earlier than i . Hence (8a), which represents (8), is true even though Max started to run at 2pm, contrary to intuitions.

To overcome this problem, one might revise the definition of $\text{AT3pm}(A)$ so that 3pm identifies the *initial bound* of the interval at which A is true. That is, AT3pm may be defined as follows:

$\text{AT3pm}(A)$ is true at (w,i) if 3pm is the initial bound of i and A is true at (w,i) and for every interval j such that i is strictly contained in j , A is false at (w,j) ; it is false if 3pm is not the initial bound of i or A is false at (w,i) or there exists an interval j such that i is strictly contained in j , and A is true at (w,j) ; and otherwise it is undefined.

This new definition for $\text{AT3pm}(A)$ now identifies 3pm as the initial bound of an interval i at which A is true such that if j contains i then A is false at j , and hence 3pm is the time at which A *starts* to be true. This temporal structure can be pictorially represented as follows:



Hence the formula (8a) is now true only if 3pm is the time at which Max *starts* to run, and hence the new definition for AT3pm allows the formula (8a) to capture (8)'s inchoative interpretation.

However, the new definition of AT3pm does not capture the natural reading of the *stative* sentence (9).

(9) Max was asleep at 3pm

The representation of (9) is (9a), and by our revised definition of AT3pm , (9a) entails that Max *starts* to sleep at 3pm.

(9a) $\text{PAST}_{(v,t)}[\text{AT3pm}(\text{asleep}(\text{max}))]$

Clearly, this is not the natural interpretation of (9), for (9) may be true when Max starts to sleep *before* 3pm (but is still sleeping at 3pm).

For this reason, we propose an alternative way to account for (8)'s inchoative interpretation, which involves barring (8a) as the representation of (8) and proposing a different representation. We do this by re-defining the definition of "At 3pm"; we add to Richards' original analysis of "At 3pm" the condition that $AT3pm(A)$ can be true only if A denotes a proposition from Mo or S . So $AT3pm$ is now defined as follows:

$AT3pm(A)$ is true in a model M at (w,i) if $\llbracket A \rrbracket^{<M,g>} \in Mo$ or $\llbracket A \rrbracket^{<M,g>} \in S$ and A is true at (w,i) and i is 3pm; it is false if either $\llbracket A \rrbracket^{<M,g>}$ is not a member of Mo and $\llbracket A \rrbracket^{<M,g>}$ is not a member of S , or A is false at (w,i) or i is not 3pm; and otherwise it is undefined.

This will allow (9a) to represent the natural interpretation of (9) (the proof of this is postponed until later), but it will bar (8a) as a representation of (8), because now (8a) will always be false (since $run(max)$ denotes a process).

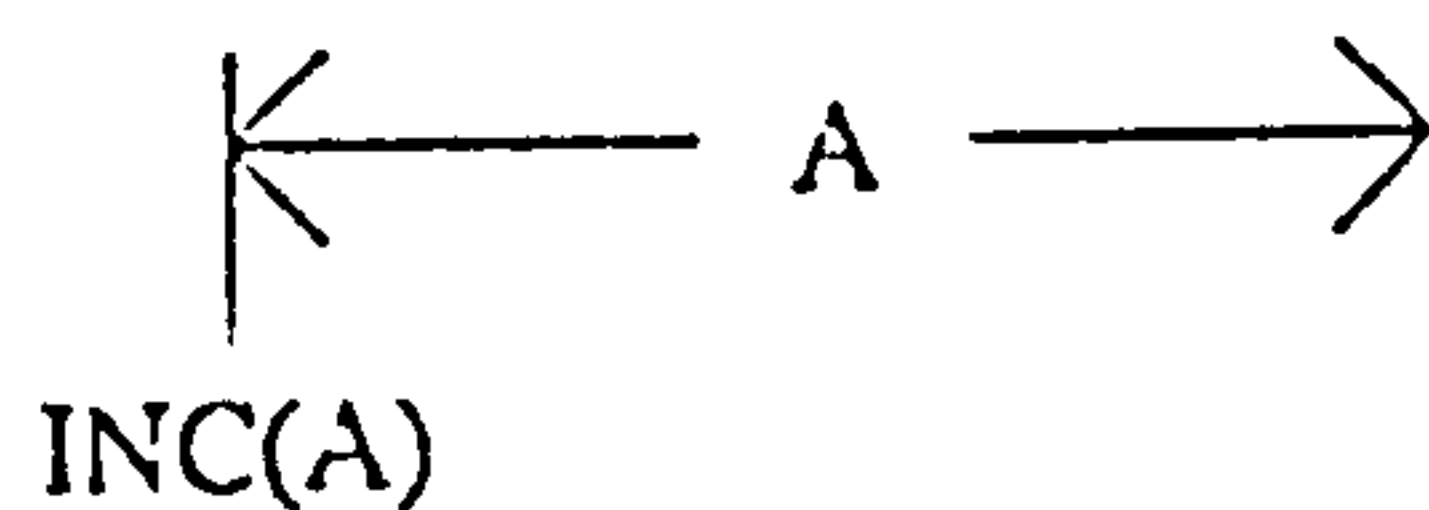
We now have the task of proposing another representation of (8a). In order to represent (8) with our new definition of $AT3pm$, we will introduce an operator "INC" (glossed as "inchoative") that works on the process $run(max)$ to identify the time at which the process starts. $INC(run(max))$ will denote a proposition from Mo (and so $AT3pm(INC(run(max)))$ can be true) and $INC(run(max))$ will be true at (w,i) only if i is the initial bound of an interval j such that $run(max)$ is true at (w,j) and if k contains j then $run(max)$ is false at (w,k) . Thus the formula $INC(run(max))$ will be true only at the initial bounds of the largest connected intervals at which $run(max)$ is true, and hence it will be true at (w,i) only if Max starts to run at (w,i) . So $INC(run(max))$ will denote the inchoative sense of "Max ran" as it appears in sentence (8) and this formula will be embedded in our analysis of (8); in fact, our new representation of (8) will be (8b).

(8b) $PAST_{(v,i)}[AT3pm(INC(run(max)))]$

We will define INC as follows:

$INC(A)$ is true in a model M at (w,i) if $\llbracket A \rrbracket^{<M,g>} \in Pr$ and there is an interval j such that A is true at (w,j) and i is the initial bound of j , and for any k such that j is contained in k , A is false at (w,k) ; it is false if $\llbracket A \rrbracket^{<M,g>}$ is not in Pr or there is no interval j such that A is true at (w,j) and i is the initial bound of j , or there is an interval k such that j is contained in k and A is true at (w,k) ; and otherwise it is undefined.

Any sentence $INC(A)$ is true only if A denotes a process. $INC(A)$ refers to a proposition from Mo (because the initial bounds of intervals are moments), and it is true at those moments at which the process A starts, since it is true at the initial bounds of the largest connected intervals at which A is true. This temporal structure can be pictorially represented as below:



The representation of (8) is now (8b) (it cannot be (8a) because (8a) is now always false), and by the above definitions of AT3pm and INC, (8b) captures the natural interpretation of (8): 3pm will be the time when Max *starts* to run.

(8b) $PAST_{(v,t)}[AT3pm [INC(run(max))]]$

Note that $INC(asleep(max))$ is false because $asleep(max)$ denotes a state, and so (9) has a very different logical form to (8). In fact, we will preserve the logical form of (9) as (9a). But we will postpone until the next chapter the proof that the above definition of AT3pm can also capture the natural reading of (9) in the formula (9a), for we are concerned here only with defining the aspectual operators CP_e , PR_e , INC etc. in our interpretation of the classification of aspect.

It is important to note that the operators INC and CP_e both define mappings from the set Pr to the set Mo, but they are distinct, for in general the proposition referred to by $INC(run(max))$ is different from the proposition referred to by $CP_e(run(max))$.

6.4 START

There is a natural reading of sentence (10) in which Max *starts* to run to the station at 3pm, and this process eventually *culminates*; i.e. Max eventually reaches the station.

(10) Max ran to the station at 3pm

This raises a puzzle. Since we intuitively regard (10) to be about a culminated process (since (10) entails the culmination), the representation of (10) must invoke the representation of the culminated process "Max run to the station". Suppose that, in agreement with Thomason and Stalnaker (1973), we represent the adverbial "To the station" as a modifier on predicates, and suppose that the formula $[TOstation(run)](max)$ represents the culminated process sentence "Max run to the station". So this formula denotes a proposition from Mo such that if it is true at the moment m, then the

'conclusion' of the culminated process (i.e. Max reaches the station) is true at m ⁴⁶. Then since (10) intuitively entails the 'conclusion', the formula $[TOstation(run)](max)$ must be part of the representation of (10).

Suppose that "AT3pm" is as we defined it above, and the representation of (10) is (10a).

(10a) $PAST_{(v,t)}[AT3pm([TOstation(run)](max))]$

Then by the above definition of AT3pm, (10a) asserts that 3pm is the time that Max reaches the station, contrary to (10)'s inchoative reading. The puzzle is: how can one represent (10) to account for its inchoative reading?

The inchoative reading of (10) must be represented with the formula $AT3pm(B)$ for some formula B , such that B is true at (w,i) only if Max *starts* the process of running to the station at (w,i) , and the process must then culminate in Max reaching the station, i.e. B will entail that $[TOstation(run)](max)$ is eventually true. For with this condition on the truth of B and the above definition of AT3pm, the formula $AT3pm(B)$ will be true at (w,i) only if Max starts the process of running to the station at 3pm and this process will culminate, which is what we require.

But as we have already argued, we cannot identify the process that leads to the culmination $[TOstation(run)](max)$ independently of context (cf. section 6.2). In the example under consideration here, the suitable process may start when Max puts on his coat and hat, or when he opens the door to go out, and so on. To reflect this in the formalism, we will refer *deictically* to the process. So I will replace the formula B in the above representation of (10) with the formula $START_e([TOstation(run)](max))$, where $g_e(e)$ will pick out the suitable process given the context of utterance of (10). $START_e([TOstation(run)](max))$ will be defined so that it is true at (w,i) only if the process $g_e(e)$ *starts* at (w,i) , and this process will eventually 'culminate'; i.e. $[TOstation(run)](max)$ will eventually be true.

The operator $START_e$ is like the operator INC in that it must identify the times at which a process starts. However, $START_e$ is distinct from INC in two crucial respects: first, the parameter e that appears in $START_e$ refers deictically to the process and there is no deictic reference to a process in the interpretation of INC (INC(A) simply characterises the start of the process A); and second, $START_e$ will assert that the process *culminates*, whereas INC does not.

⁴⁶ We will not speculate here on how the modifier TOstation is to be defined.

The operator $START_e$ is defined below:

$START_e(A)$ is true in a model M at (w,i) if

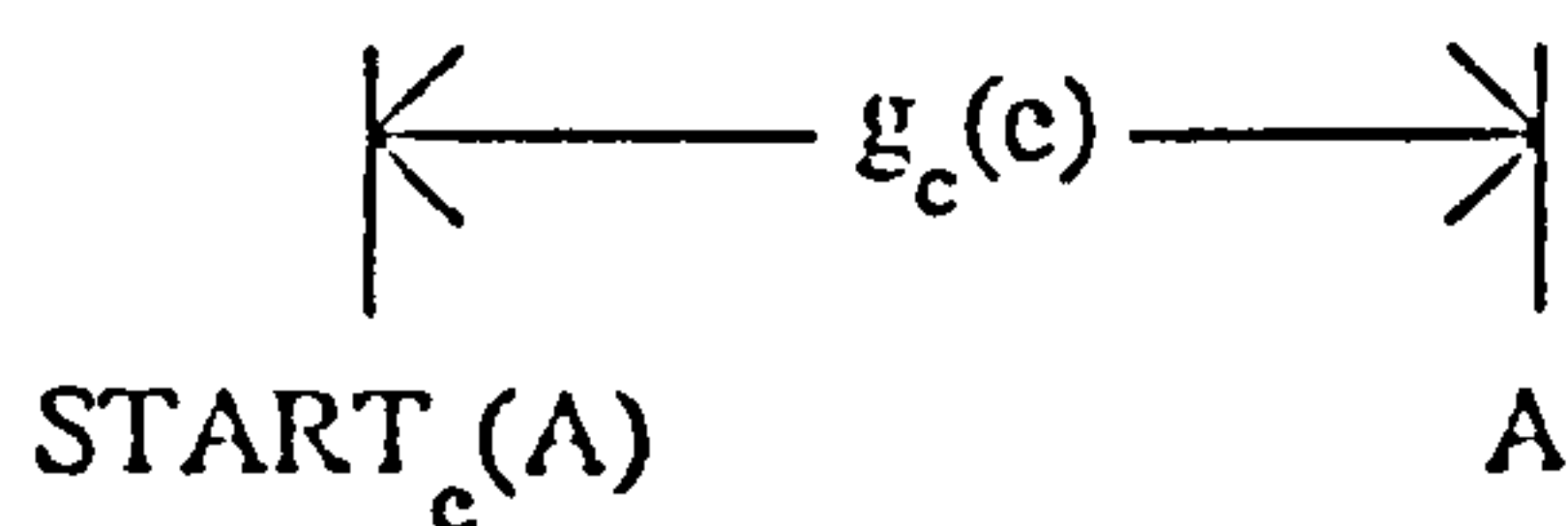
- (a) $\llbracket A \rrbracket^{<M,g>} \in Mo$ and $g_e(e) \in Pr$, and
- (b) for all indices $(w',i') \in W \times I$, if $\llbracket A \rrbracket^{<M,g>}(w',i') = 1$ then $g_e(e)(w',j') = 1$ for some interval j' such that i' is its final bound, and
- (c) $g_e(e)(w,j) = 1$ for some interval j such that i is the initial bound of j and there is no interval k such that k contains j and $g_e(e)$ is true at (w,k) , and l is the final bound of j and A is true at (w,l) ;

it is false if any of the conditions (a), (b) or (c) do not hold;

and otherwise it is undefined.

Condition (a) in the above definition ensures that $START_e(A)$ is true only if A refers to a proposition from Mo and $g_e(e)$ is a process. So $START_e(A)$ is about a moment structure (i.e. A) and a process (i.e. $g_e(e)$) that is determined by context, which is as required. As with the definitions of CP_e and PR_e , the semantic role of condition (b) is to restrict our choices of $g_e(e)$ to a process that is necessarily related to the moment structure denoted by A : if A is true then the process $g_e(e)$ must have been true just beforehand. This is intended to reflect the intuition that the culmination of A was the *result* of the process $g_e(e)$.

Condition (c) states that $START_e(A)$ is true in the model M at (w,i) only if i is the initial bound of an interval j such that $g_e(e)(w,j) = 1$ and A is true at (w,l) where l is the final bound of j , and for all the intervals k that contain j , $g_e(e)(w,k) = 0$. Thus $START_e(A)$ is true at (w,i) only if i identifies the start of the process $g_e(e)$, which in turn culminates in A . This can be represented pictorially as below:



The representation of sentence (10) that captures the reading where Max *starts* to run to the station at 3pm is (10b)⁴⁷.

(10b) $PAST_{(v,t)}[AT3pm[START_e([TOstation(run)](max))]]$

Note that by condition (c) in the truth conditions of $START_e$, the truth of $START_e(A)$ at (w,i) entails that A is true at (w,l) for some interval l that is later than i . There are two important properties of our theory that arise directly from this that are worth mentioning. First, any natural language culminated process sentence remains a culminated process sentence under adverbial modification with $AT3pm$, because (assuming that A represents a culminated process sentence) $START_e(A)$ entails A and so entails that the 'conclusion' associated with A occurs. Hence in our theory natural language expressions maintain their culminated process status under adverbial modification. Second, the truth conditions of $START_e$ have a suppressed future tense element to them, because $START_e(A)$ entails that A is true *at some time in the future*. Hence a sentence like (11) may be true with respect to a model M , but when we utter (11) we will not *know* if what we uttered was true until a few days later when we see if the QE2 actually reaches America.

(11) The QE2 sailed to America at 3pm today

This is related to the long-standing philosophical debate that concerns the relationship between the truth of future tensed sentences like "It will rain tomorrow" and their assertability.

A problem we now have given our proposed representation of (10) is to decide which expressions denoting members of Mo invoke the operator $START_e$ when combining with point adverbials and which do not. For example, we have argued that (10b) is a possible representation of (10), but one would not wish (12b) to be possible representation of (12).

(12) Max won the race at 3pm

(12b) $PAST_{(v,t)}[AT3pm(START_e(win(max,race)))]$

There is only one natural interpretation of (12), and that is that the 'conclusion' of winning the race, i.e. Max crosses the finish line in first place, occurs at 3pm. Given our definition of $AT3pm$, this reading is captured in the formula (12a) and not (12b), and so the only possible representation of (12) must be (12a).

(12a) $PAST_{(v,t)}[AT3pm(win(max,race))]$

The principle that decides whether we can have $START_e$ in the representation of the sentence containing a point adverbial seems to be based on whether the main verb is represented by a process

⁴⁷ The phenomenon of how culminated process expressions combine with point adverbials such as "At 3pm" is very puzzling. Some culminated processes seem not to combine with them at all, such as "?Max wrote a dissertation at 3pm". Our theory fails to say anything about these sentences.

predicate or a culmination predicate (a process (n-place) predicate p is one where for any terms x_1, \dots, x_n , $p(x_1, \dots, x_n)$ denotes a proposition from Pr , and a culmination (n-place) predicate p is one where for any terms x_1, \dots, x_n , $p(x_1, \dots, x_n)$ denotes a proposition from Mo). In the case of (10), the main verb, i.e. run, is represented by a process predicate and the analysis of (10) can be given in terms of $START_e$. In the case of (12), the main verb, i.e. win, is represented by a culmination predicate and the analysis of (12) is not given in terms of $START_e$. If we were to construct a grammar to accompany our semantic interpretation of the classification of aspect, this grammar would have to formulate this principle.

There are other possible representations of (10) and (12) given the aspectual operators we have defined so far, namely (10c) and (12c).

- (10c) $PAST_{(v,t)}[AT3pm(INC(PR_e([TOstation(run)](max))))]$
 (12c) $PAST_{(v,t)}[AT3pm(INC(PR_e(win(max))))]$

Given the definitions of $AT3pm$, INC and PR_e , (12c) is true only if 3pm is the time when Max *starts* the process of winning the race, and this process does *not* necessarily culminate; the interpretation of (10c) is similar. This clearly doesn't capture any natural interpretation of (10) or (12), and so (10c) and (12c) should be barred as possible representations.

We will bar (10c) and (12c) as representations of (10) and (12) by proposing that the operator PR_e can be used to represent a natural language expression only if that expression contains a verb in the progressive *-ing* form. In other words, if we were to construct a grammar to accompany our representation of natural language expressions, then when we construct the progressive *-ing* form of a culmination verb in the syntax, it is only then that we introduce the operator PR_e in the corresponding semantics. As a result, the formula (13) cannot represent the clause "Max win the race", but it can (and will) represent the clause "Max winning the race"⁴⁸.

- (13) $PR_e(win(max, race))$

So clauses like "Max win the race" and "Max build the house" are not ambiguous at all, as we supposed when we discussed sentences like "Max was winning the race" and "Max was building the house" (cf. section 6.2). Instead, "Max win the race" and "Max build the house" always denote an event that culminates and "Max winning the race" and "Max building the house" always denote a

⁴⁸ The rule for constructing the progressive *-ing* form of a process verb like "run" would not have any semantic effect though: i.e. "Max run" and "Max running" are both represented by the formula $run(max)$.

process⁴⁹. As a result, the formula (12c) cannot represent (12), as desired.

7 Our Approach Compared with Previous Interval-Based Approaches

We have formulated the classification of aspect in an interval-based framework, so let us see how it compares with previous interval-based accounts.

Dowty's interval based formulation of the classification of aspect adopts the Heterogeneous Strategy discussed in chapter 2. He characterises a heterogeneous semantics for *accomplishments* (i.e. culminated processes) such as "Max build a house" where this sentence may be true at an interval i and false at a subinterval j of i . We have argued that this approach is unworkable.

Our interpretation of the classification of aspect takes on a wholly different approach to Dowty's. We do not adopt the Heterogeneous Strategy, for we do not give an analysis of the sentence "Max build a house" such that this sentence may be true at an interval i and false at some subinterval j of i . Indeed, such truth conditions for "Max build a house" would not even be expressible in the framework IQ because of the homogeneity principle (3), which entails that if $\text{build}(\text{max}, \text{house})$ is true at (w, i) , then it is true at (w, j) for all subintervals j of i .

- (3) An atomic sentence A is true at the index (w, i) only if for all subintervals j of i , A is true at (w, j) .

IQ, unlike (Dowty 1979), is an interval semantics which maintains *homogeneity* for boolean combinations of atomic sentences. Thus one important original feature of our theory is that it is the first formulation of the classification of aspect to be stated in a *homogeneous* interval-based framework.

We proposed that one can classify the sentence "Max ran" as a culminated process, and we represented the culminated process sense of "Max ran" by the formula $\text{CP}_e(\text{run}(\text{max}))$. This formula received its semantic interpretation in virtue of *context*, because its truth depended on the value assigned to the parameter e by the function g_e with respect to the context c . This is another original feature of our formulation of the classification of aspect: *context* is allowed to play a non-trivial role in the semantics of the classification of aspect. This allows us to account in our semantic theory for the fact that sentence (2) is acceptable in certain contexts but not in others.

⁴⁹ The progressive operator PROG will operate on the representation of the clause "Max winning the race" and *not* "Max win the race", and adding the progressive operator PROG to the formula (13) in the semantics will correspond in the syntax to adding the progressive auxiliary "be" to the clause "Max winning the race" to form "Max be winning the race".

(2) Max ran in four minutes (this morning)

(2) is acceptable in our theory with respect to a context c if g_c assigns the parameter e a value in the interpretation of $CP_e(\text{run}(\text{max}))$, and if g_c does not assign the parameter e a value, then sentence (2) is unacceptable. Dowty's theory cannot account for this.

8 Conclusion

In this chapter, I have offered a formal interpretation of the taxonomy of aspect in the framework IQ. The theory offered a new approach to formalising the taxonomy of aspect because it contained essentially two original features; the theory is stated in a *homogeneous interval-based* framework, and *context* plays a central role in describing the semantics of the classification of aspect. Thus this formulation of the taxonomy of aspect provides an arena in which to tackle the imperfective paradox anew. Can our theory yield a solution to the imperfective paradox, in a way that overcomes the problems encountered in previous attempts? This is explored in the next chapter.

Chapter 7

A Solution to the Imperfective Paradox

1 Introduction

The objective of this chapter is to build on the classification of aspect described in the previous chapter in an attempt to solve the imperfective paradox. We aim to give a *principled* solution, and to this end, the theory laid out in the previous chapter must not only lead to a solution to the imperfective paradox, but it must also account for other temporal phenomena. For example, it must fit together with a satisfactory analysis of point adverbials such as "At 3pm" as it appears in sentences (1) and (2).

- (1) Max ran at 3pm
- (2) Max won the race at 3pm

Our definition of the progressive must also explain why sentence (3) does *not* entail (4).

- (3) Max was kissing every girl
- (4) Max was kissing Susan

The object of this chapter is to provide definitions in IQ of the progressive aspect and various temporal adverbials that achieve these tasks.

2 The Semantics of Temporal Adverbials in IQ

2.1 "In"-Adverbials

In the previous chapter we proposed that an "in"-adverbial such as "in four minutes" operates only on culminated process expressions to produce a culminated process expression. This reflects Moens' idea that an "in"-adverbial takes a culminated process as input and it outputs a culminated process. Consider sentence (5).

- (5) Max built a house in two years

Intuitively, (5) entails that the house was completed, and the "in"-adverbial "in two years" qualifies

the length of time over which the process of building a house took place. But as we argued in the previous chapter, the process of Max building a house is not uniquely specified independently of context. For example, a suitable process may be Max preparing to build the house, finding the funds and so on, as well as doing the actual building. Alternatively the process may be just the action of building. Context determines which of these we are talking about when we utter (5), and so determines which process is said to be two years in length.

To represent the fact that context determines which process the "in"-adverbial refers to, we may refer deictically to the process in the representation of "in"-adverbials. That is, one may represent the "in"-adverbial "in ten minutes" in IQ as an indexical operator of the form $IN10mins_e$, where the value of $g_e(e)$ in $IN10mins_e(A)$ will be the suitable process associated with the culminated process A and the truth of $IN10mins_e(A)$ will require the process $g_e(e)$ to go on for ten minutes and then culminate in A.

In addition, as we argued in the previous chapter, the possible choices for $g_e(e)$ in the truth conditions of $IN10mins_e(A)$ must be restricted by the relation R_1 in that $g_e(e)$ must stand in the relation R_1 to the denotation of A: this captures the intuition that whenever the culminated process A is true, then $g_e(e)$ must have been true just before. The relation R_1 is repeated below.

Relation R_1

The process proposition pr stands in the relation R_1 to the moment-structure proposition mo if for all $(w', i') \in W \times I$, if $mo(w', i') = 1$ then there is some interval j' such that i' is the final bound of j' and $pr(w', j') = 1$.

The truth of $IN10mins_e(\text{build}(\text{max}, \text{house}))$ will require $g_e(e)$ to stand in the relation R_1 to the denotation of $\text{build}(\text{max}, \text{house})$, and the result is to effectively restrict our possible choices for $g_e(e)$. For example, $g_e(e)$ could not be the process "John swim" in a model M that captures the intuition that there is *no* necessary relation between John swimming and Max building a house. The adverbial "in ten minutes" is defined as below so as to incorporate these ideas:

$IN10mins_e(A)$ is true in a model M at (w, i) if

- (a) the proposition denoted by A (which we refer to as $[A]^{<M, g>}$) is a member of Mo and $g_e(e)$ is a member of Pr , and
- (b) for all $(w', i') \in W \times I$, if $[A]^{<M, g>}(w', i') = 1$ then there is an interval j' such that i' is the final bound of j' and $g_e(e)(w', j') = 1$, and
- (c) A is true at (w, i) and the largest interval j such that i is the final bound of j and $g_e(e)(w, j) = 1$ is ten minutes long;

it is false if any of the conditions (a), (b) or (c) do not hold;

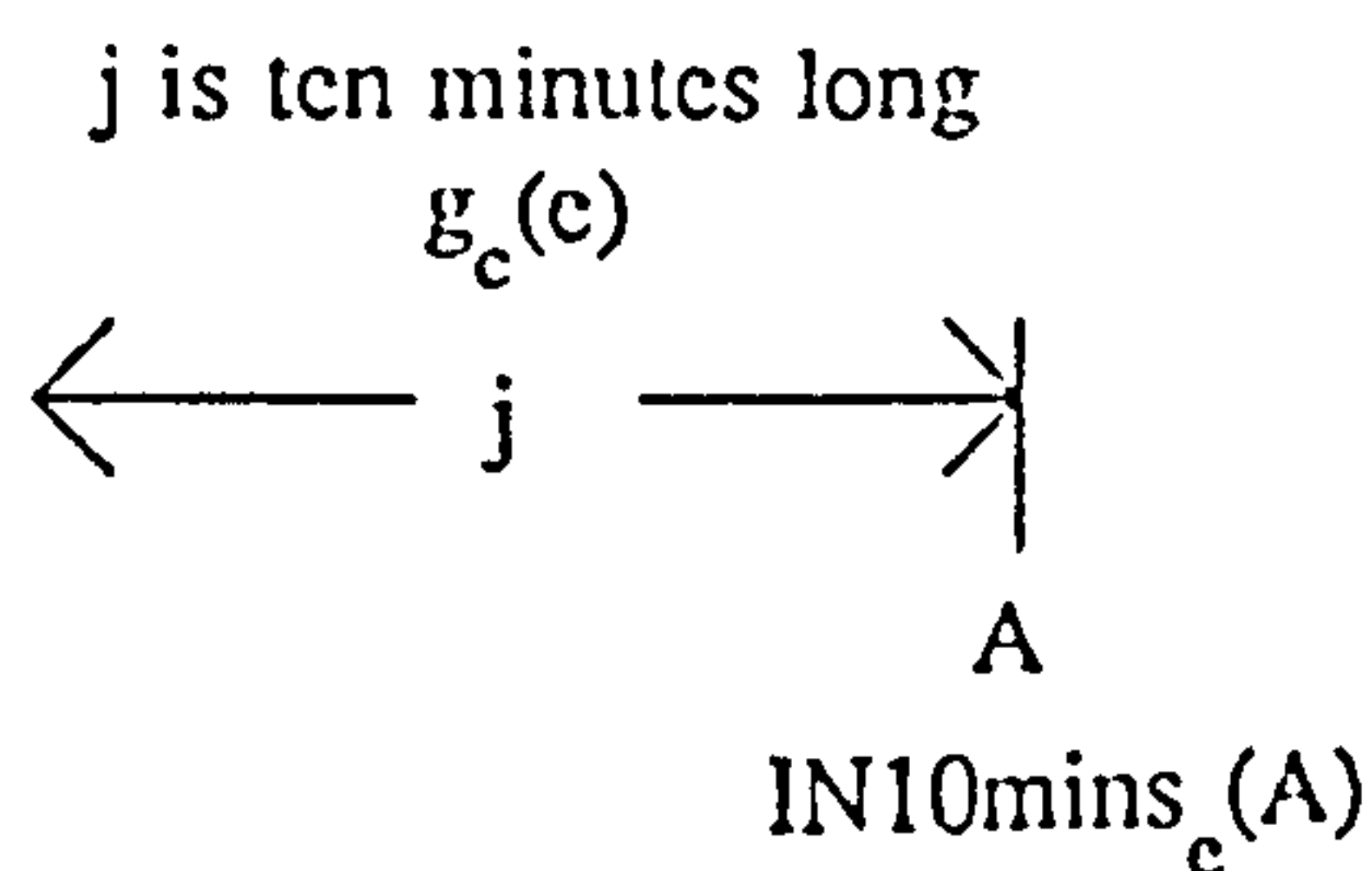
and otherwise it is undefined.

Let us discuss the semantic roles of conditions (a), (b) and (c) in the above definition. First by condition (a), $\text{IN10mins}_e(A)$ is false where $\llbracket A \rrbracket^{<M,g>}$ is not a member of Mo or $g_e(e)$ is not a member of Pr. The fact that the proposition denoted by A must be a member of Mo reflects the intuition that the "in"-adverbial qualifies only culminated process expressions (since these expressions all denote propositions from Mo).

Condition (b) expresses the necessary relation R_1 between the proposition denoted by A and the proposition $g_e(e)$. It essentially represents the idea that whenever A is true, then $g_e(e)$ must have been true just beforehand, and so it captures the intuition that A is the *result* of the process $g_e(e)$. As we discussed in the previous chapter, this condition effectively restricts our possible choices for $g_e(e)$. For example, if A is *build(max,house)*, then we know that $g_e(e)$ cannot be the process denoted by "John swim" if the model M captures the intuition that there is no relation between John swimming and Max building a house.

By condition (c), $\text{IN10mins}_e(A)$ is true at (w,i) only if A is true at (w,i) . But by condition (a) we know that A denotes a proposition from Mo, so i must be a moment. Hence $\text{IN10mins}_e(A)$ is true at (w,i) only if i is a moment, and so it denotes a proposition from Mo. The fact that $\text{IN10mins}_e(A)$ denotes a proposition from Mo reflects the intuition that expressions containing the adverbial "in ten minutes" are culminated processes.

Furthermore according to condition (c), $\text{IN10mins}_e(A)$ is true at (w,i) if A is true at (w,i) and in addition the largest connected interval j such that i is the final bound of j and $g_e(e)$ is true at j (we know such an interval exists by condition (b)) is ten minutes long. This produces the following temporal structure:



Note that since condition (c) stipulates that the ten minute long interval j must be the *largest* interval at which $g_e(e)$ is true, our truth conditions for IN10mins_e produces an interpretation of "Max won the race in ten minutes" that is synonymous with "It took (exactly) ten minutes for Max to win the race". The reading of "Max won the race in ten minutes" that corresponds to "Max won

the race in *less than* ten minutes" would be represented using a different operator to $IN10mins_e$.

Let us examine a particular example. Consider sentence (5).

(5) Max built a house in two years

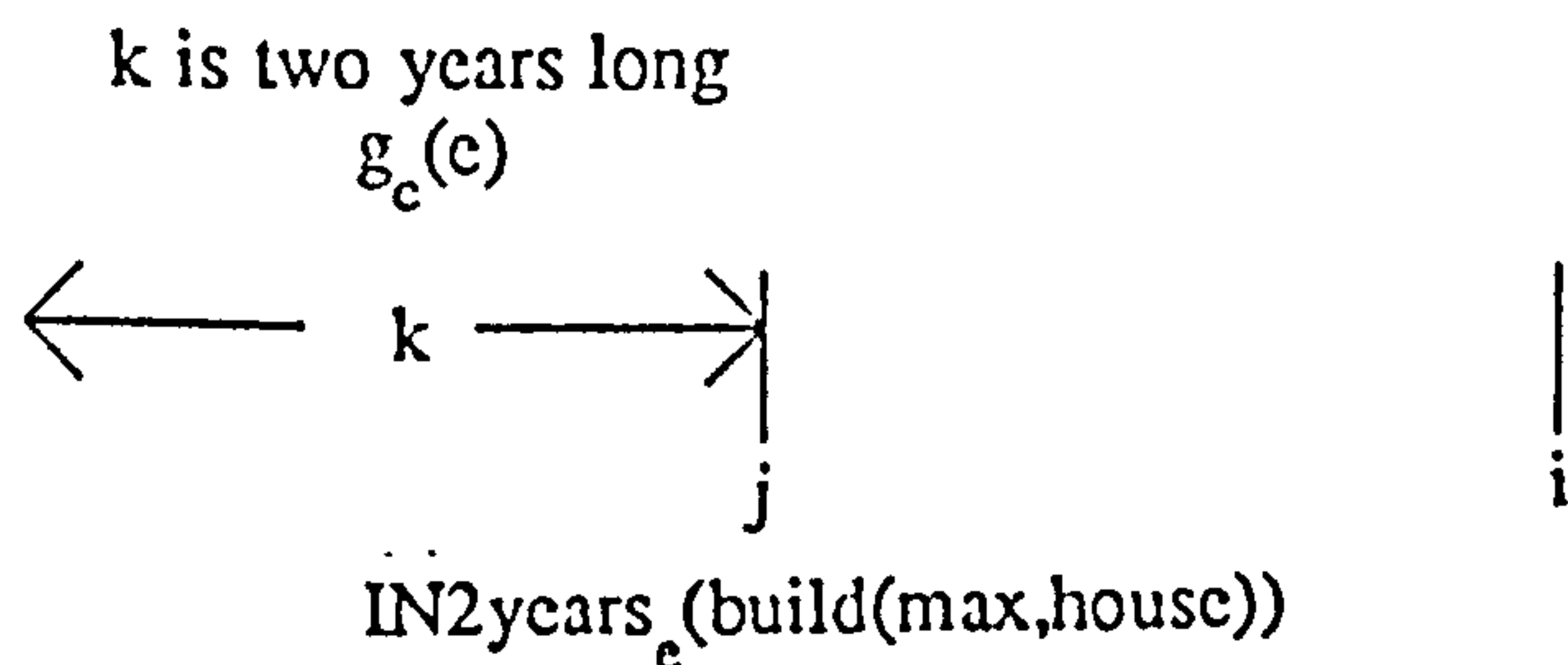
The representation of (5) is (5a)⁵⁰.

(5a) $PAST_{(v,i)}[IN2years_e(build(max,house))]$

$g_e(e)$ corresponds to the contextually determined process of Max building a house. Let us evaluate the truth conditions of (5a). (5a) is true in a model M at (w,i) if $g_e(v) = w$, $g_e(t) = i$ and there is an interval j earlier than i such that (5a1) is true at (w,j) .

(5a1) $IN2years_e(build(max,house))$

This is the case if and only if (a) $[[build(max,house)]]^{<M,g>} \in Mo$ and $g_e(e) \in Pr$ and (b) for all indices $(w',i') \in W \times I$, if $build(max,house)$ is true at (w',i') then $g_e(e)(w',j') = 1$ for some interval j' whose final bound is i' , and (c) $build(max,house)$ is true at (w,j) and the largest interval k such that j is the final bound of k and $g_e(e)(w,k) = 1$ is two years long. The truth of (5a) thus requires the following temporal structure, as desired.



Under very special circumstances, "in"-adverbials such as "in four minutes" may combine felicitously with the expression "Max ran". Consider sentence (6) in the context where Max runs a mile every morning.

⁵⁰ The definition of the past tense operator $PAST_{(v,i)}$ was given in chapter 6.

(6) Max ran in four minutes

The representation of sentence (6) is (6a), where the operator CP_e is as defined in the previous chapter.

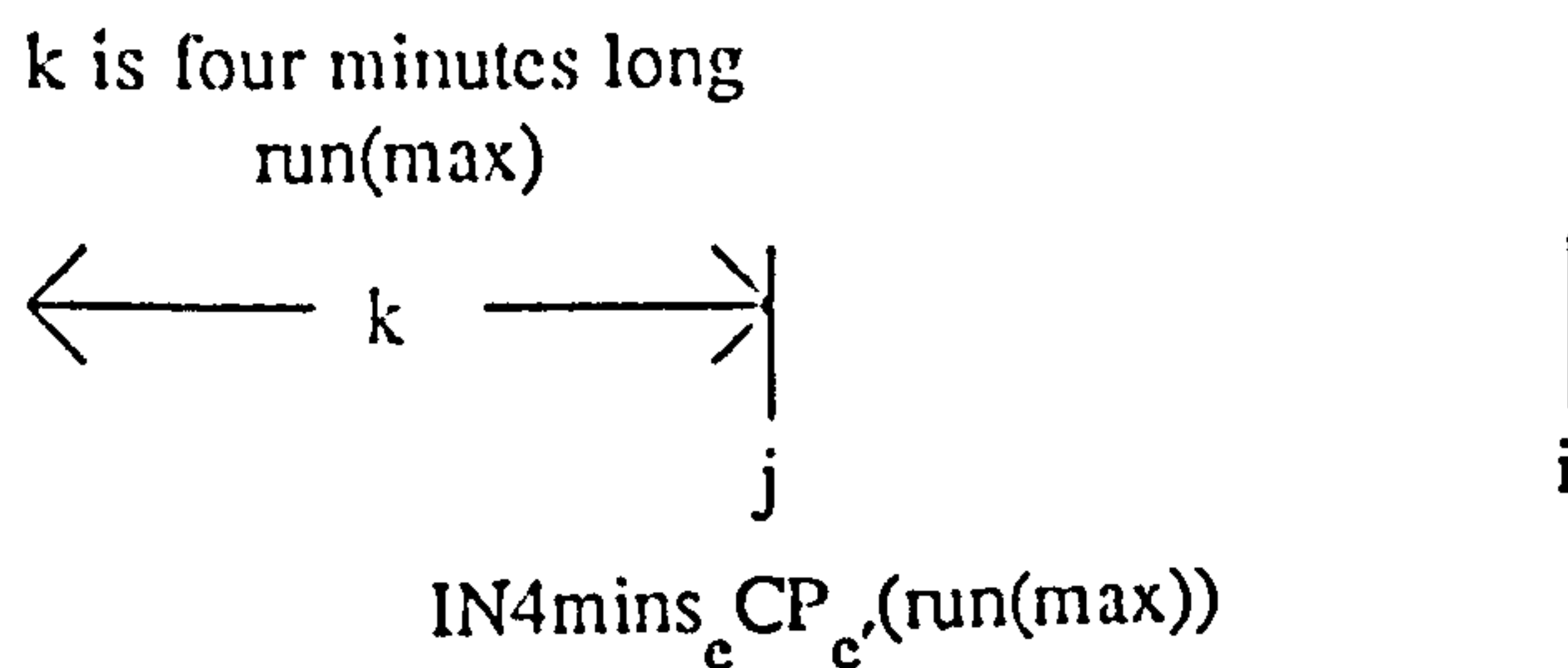
(6a) $PAST_{(v,t)}[IN4mins_e[CP_e(run(max))]]$

Note that we have two distinct parameters e and e' . $g_c(e')$ will be the culmination to $run(max)$ given by the context c . In this particular context, $g_c(e)$ must be the proposition that Max completes running a mile. $g_c(e)$ will be the process that leads to the culmination denoted by $CP_e(run(max))$; i.e. $g_c(e)$ will be the proposition denoted by $run(max)$. How e and e' achieve these denotations is not a matter we will consider here.

Let us examine the truth conditions of (6a) with these assignments to e and e' . (6a) is true at (w,i) if and only if $g_c(v) = w$ and $g_c(t) = i$, and there exists an interval j such that j is earlier than i and (6a1) is true at (w,j) .

(6a1) $IN4mins_e[CP_e(run(max))]$

This is the case if and only if (a) $CP_e(run(max))$ denotes a proposition from Mo and $g_c(e)$ (i.e. the proposition denoted by $run(max)$) is a proposition from Pr , and (b) for every index $(w',i') \in W \times I$, if $CP_e(run(max))$ is true at (w',i') then $run(max)$ is true at (w',j') for some interval j' whose final bound is i' , and (c) $CP_e(run(max))$ is true at (w,j) and the largest interval k such that j is the final bound of k and $run(max)$ is true at (w,k) is four minutes long. Condition (a) is satisfied since as we observed in the previous chapter, $CP_e(run(max))$ denotes a proposition from Mo and $run(max)$ denotes a proposition from Pr . Furthermore condition (b) is satisfied directly as a result of the condition (b) in the truth definition of $CP_e(run(max))$ given in the previous chapter (we will not go into the proof here). So one can see from these truth conditions that the truth of (6a) requires the following temporal structure, as desired:



2.2 Point Adverbials

The definition of the point adverbial "At 3pm" must capture the contrast between the inchoative interpretation of sentence (1), where Max *starts* to run at 3pm, and the natural interpretation of (2), where Max actually wins at 3pm rather than *starts* to win.

- (1) Max ran at 3pm
- (2) Max won the race at 3pm

The definition for "At 3pm" should also allow sentence (7) to be true if Max starts to sleep *before* 3pm (and is still sleeping at 3pm).

- (7) Max was asleep at 3pm

I suggest that the following truth definition of "At 3pm", which was first introduced in the previous chapter, captures these properties.

AT3pm(A) is true at (w,i) if (a) $\llbracket A \rrbracket^{<M,g>} \in Mo$ or $\llbracket A \rrbracket^{<M,g>} \in S$ and (b) A is true at (w,i) and i is 3pm; it is false if either condition (a) or condition (b) does not hold; and otherwise it is undefined.

Let us investigate the analyses of sentences (1), (2) and (7) above. The representation of (1) cannot be (1a) because run(max) denotes a process and so by condition (a) of the definition of AT3pm, AT3pm(run(max)) is always false.

- (1a) PAST_(v,t)[AT3pm(run(max))]

As argued in the previous chapter, we will analyse (1) in terms of the inchoative sense of "Max run", which in our theory is represented by INC(run(max)) (the operator INC was defined in the previous chapter). So the logical form of (1) is (1b).

(1b) $PAST_{(v,t)}[AT3pm[INC(run(max))]]$

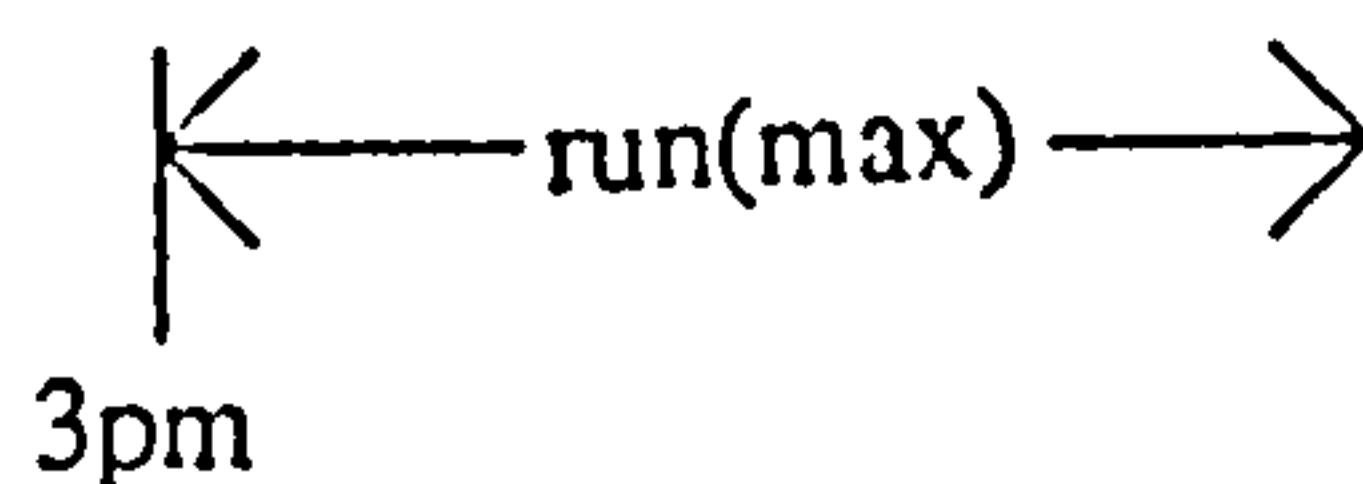
(1b) is true in a model M at (w,i) just in case $g_c(v) = w$, $g_c(t) = i$, and there exists an interval j earlier than i such that (1b1) is true at (w,j) .

(1b1) $AT3pm[INC(run(max))]$

This is the case if and only if j is 3pm and (1b2) is true at (w,j) .

(1b2) $INC(run(max))$

This is the case if and only if $[run(max)]^{<M,g>} \in Pr$, and there is an interval k such that $run(max)$ is true at k and j is the initial bound of k and for any interval l such that k is contained in l , $run(max)$ is false at l . Hence the truth of (1) requires the following temporal structure where Max *starts* to run at 3pm, which is just what is required to capture its inchoative interpretation.



The logical form of (2) is (2a).

(2) Max won the race at 3pm

(2a) $PAST_{(v,t)}[AT3pm(win(max,race))]$

(2a) is true at (w,i) if and only if $g_c(v) = w$, $g_c(t) = i$, and there exists an interval j earlier than i such that (2a1) is true at (w,j) .

(2a1) $AT3pm(win(max,race))$

This is the case if and only if j is 3pm and $win(max,race)$ is true at (w,j) . The moment at which $win(max,race)$ is true is understood as the time at which the 'conclusion' to winning, i.e. Max crossing the finish line, occurs. So according to the truth conditions of (2a), 3pm coincides with the time that Max crosses the finishing line. This agrees with the natural interpretation of (2).

The truth conditions of sentences (1) and (2) substantiate the claim that the above definition of point adverbials captures the natural interpretations of (1) and (2). Thus this theory overcomes

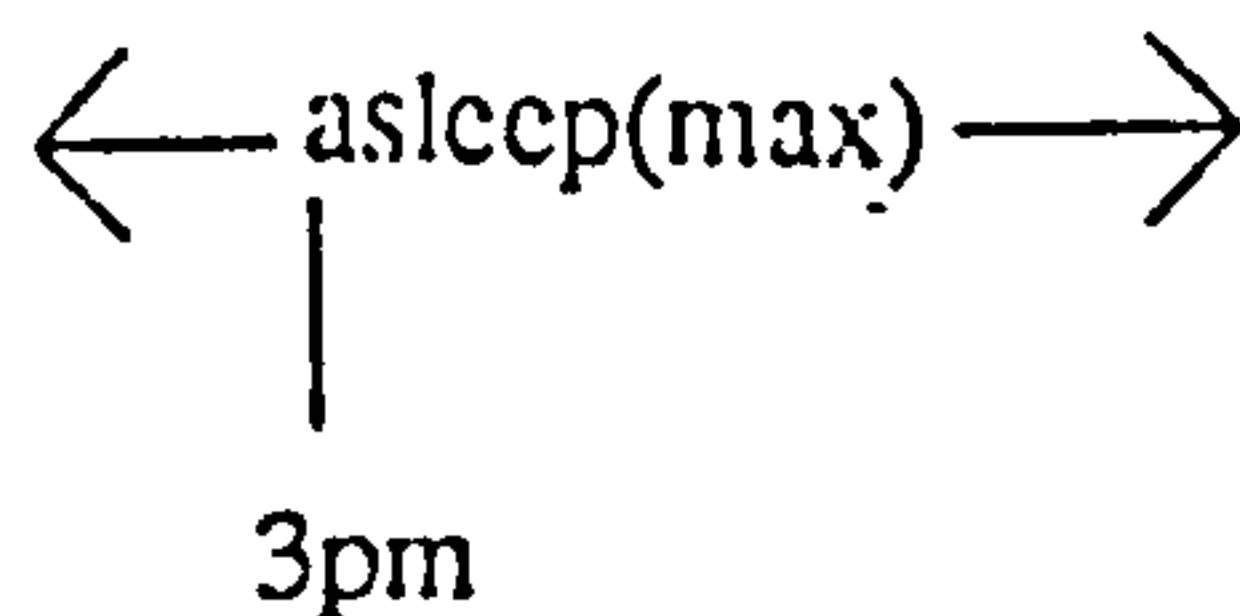
the problems encountered in Dowty's (1979) heterogeneous interval-based theory and Parsons' (1984) event-based theory (cf. chapters 2 and 4).

Now let us consider the semantics of sentence (7). The logical form of (7) is (7a).

- (7) Max was asleep at 3pm
 (7a) $PAST_{(v,t)}[AT3pm(asleep(max))]$

(7a) is true at (w,i) if $g_e(e) = w$ and $g_t(t) = i$ and there is an interval j earlier than i such that $AT3pm(asleep(max))$ is true at (w,j) ; if and only if the proposition denoted by $asleep(max)$ is a member of Mo or S (it is, in fact, a member of S), and $asleep(max)$ is true at (w,j) and j is 3pm.

Since the proposition denoted by $asleep(max)$ is a member of S it must satisfy the condition (stated in chapter 6) that if it is true on a closed interval, then there is an open interval at which it is true. Since j is 3pm (and so j is a moment), j is contained in an open interval k such that $asleep(max)$ is true at (w,k) . So (since k is open) there must be some interval l such that l is contained in k and l is earlier than j . By the homogeneity principle maintained by the framework of IQ, $asleep(max)$ is true at l where l is earlier than j . So if the logical form of (7) is (7a), then (7) *entails* that Max was asleep before 3pm, i.e. the temporal structure is as below.



This may seem puzzling, since it is not clear that (7) should *entail* that Max was asleep before 3pm, cf. sentence (8).

- (8) At 3pm, Max was suddenly asleep

I would propose that "Max was suddenly asleep" does not refer to a state, but instead refers to a culmination, where the 'conclusion' of the culmination is that Max falls asleep. Under this classification, one would be able to get the right representation of (8). (I will not consider here the semantics of "suddenly" or how such an analysis of "Max was suddenly asleep" would be achieved however).

It has been observed that some expressions that denote propositions from Mo can be interpreted inchoatively with point adverbials such as "At 3pm". Sentence (9) is an example of this.

(9) Max ran to the station at 3pm

(9) can be interpreted to mean that Max *starts* to run to the station at 3pm, rather than reaches the station at 3pm (although I do assume that (9) entails that Max reaches the station at some time). This is compatible with the general strategy presented here. As I argued in the previous chapter, one can represent the logical form of (9) as (9a), where the operator $START_e$ is as defined in the previous chapter.

(9a) $PAST_{(v,t)}[AT3pm [START_e([TOstation(run)](max))]]$

(9a) identifies 3pm as the time when the process of Max running to the station starts, and this process eventually culminates. Thus (9a) accounts for the inchoative reading of (9)⁵¹.

In this section, I have suggested the truth definitions of various temporal modifiers. These truth definitions build on the taxonomy of aspect in IQ that was presented in the previous chapter. I claim from this that were the imperfective paradox to be solved in this theory, then this solution would fit together with explanations of other temporal phenomena, and so what we would have is a *principled* solution to the imperfective paradox. In the subsequent sections, I will present this solution.

3 The Progressive and the Imperfective Paradox

A satisfactory solution to the imperfective paradox must explain the entailment from sentence (10) to (11), and at the same time explain why there is no entailment from (12) to (13).

- (10) Max was running
- (11) Max ran
- (12) Max was winning the race
- (13) Max won the race

One would also like an explanation of the entailments from (11) to (10), and (13) to (12). This section is concerned with providing an analysis of the progressive that accounts for these intuitions.

Solving the problem of the imperfective paradox consists of two tasks. The first is to represent a semantic distinction between sentences (11) and (13). The second is to provide a

⁵¹ We suggested in the previous chapter that although (9a) is one possible representation of (9), we will not allow $PAST_{(v,t)}[AT3pm[START_e(win(max,race))]]$ to be a representation of (2).

definition of the progressive that is sensitive to this distinction and thereby results in a solution to the imperfective paradox. I dealt with the first of these tasks in the previous chapter by formulating a classification of aspect in the framework of IQ. This chapter will deal with the second; i.e. we will now define the progressive.

We will represent the progressive as an operator PROG, that will operate on the process sentence A, so that PROG(A) denotes a state which describes the process A as being in progress. That is, PROG(A) will assert that the process A began at some earlier time and has not yet stopped. This reflects Moens' idea that the progressive requires a process as input and it outputs a state which describes the process as being in progress. The truth definition of PROG is given below:

PROG(A) is true in a model M at (w,i) if and only if $[A]^{<M,g>} \in Pr$ and there exists a closed interval j such that i is a proper subinterval of j and A is true at (w,j); it is false at (w,i) if either $[A]^{<M,g>}$ is not a member of Pr, or there is no closed interval j such that i is a proper subinterval of j and A is true at (w,j); and otherwise it is undefined

The sentence PROG(A) is false where A does not denote a process proposition. Furthermore, the sentence PROG(A) must denote a state proposition, since the largest connected intervals at which PROG(A) is true are the *open* interiors of the largest connected intervals at which A is true, and so PROG(A) satisfies the condition on the members of S stipulated in the previous chapter. The truth of PROG(A) requires the following temporal structure, where curved brackets represent open intervals and square brackets represent closed intervals:

$$\begin{array}{c} (<-- \text{PROG(A)} -->) \\ [<----- \text{A} ----->] \end{array}$$

Since PROG(A) is true at the open *interior* of the interval where A is true, our definition of PROG(A) reflects the idea that it is true if the process A started at some earlier time and has not yet stopped.

3.1 The Entailments from the Progressive to the Non-Progressive

At first glance, the operator PROG does not seem to offer anything interesting towards a solution to the imperfective paradox. However, the combination of the operators PROG and PR_e , where PR_e was defined in the previous chapter, provide us with the desired analysis of sentence (12); (12) does not entail (13).

- (12) Max was winning the race
- (13) Max won the race

The formula (14) is not a possible representation of (12) because the formula $\text{win}(\text{max}, \text{race})$ denotes a proposition from Mo and *not* a proposition from Pr , and so by the definition of PROG , (14) is always false.

$$(14) \quad \text{PAST}_{(v,t)}[\text{PROG}(\text{win}(\text{max}, \text{race}))]$$

In fact, the only possible representation of (12) in our formalism is (12a), since $\text{PR}_e(\text{win}(\text{max}, \text{race}))$ represents the *process* of Max winning the race.

$$(12a) \quad \text{PAST}_{(v,t)}[\text{PROG}[\text{PR}_e(\text{win}(\text{max}, \text{race}))]]$$

I will now show that our theory blocks the entailment from (12) to (13). I will do this by constructing a model M such that (12a) is true in M at (w,i) and (13a), which is the logical form of (13), is false.

$$(13a) \quad \text{PAST}_{(v,t)}(\text{win}(\text{max}, \text{race}))$$

Suppose that sentence (12a) is true in a model M at an index (w,i) . This is the case if and only if $g_c(v) = w$ and $g_c(t) = i$, and there exists an interval $j < i$ such that (12a1) is true at (w,j) .

$$(12a1) \quad \text{PROG}[\text{PR}_e(\text{win}(\text{max}, \text{race}))]$$

This is the case if and only if $(12a2) \in \text{Pr}$, and there exists a closed interval k such that j is a proper subinterval of k and (12a2) is true at (w,k) .

$$(12a2) \quad \text{PR}_e(\text{win}(\text{max}, \text{race}))$$

This is the case if and only if (a) $[\text{win}(\text{max}, \text{race})]^{<M,g>} \in \text{Mo}$ (which it does) and $g_c(e) \in \text{Pr}$ and (b) for all indices $(w',i') \in W \times I$, if $\text{win}(\text{max}, \text{race})$ is true at (w',i') , then there is an interval j' such that i' is the final bound of j' and $g_c(e)$ is true at (w',j') (this, as we have argued, restricts our possible choices for $g_c(e)$), and (c) $g_c(e)$ is true at (w,k) .

Now the truth of $g_c(e)$ in the model M at (w,k) is consistent with the formula $\text{win}(\text{max}, \text{race})$ being false at all times in w . If $\text{win}(\text{max}, \text{race})$ is false at all times, then sentence (13a) is false in M at (w,i) .

(13a) $PAST_{(v,i)}(win(max,race))$

But this is the logical form of (13). Hence (12) does not entail (13).

The semantics of PROG provides an explanation of the entailment from (10) to (11).

(10) Max was running

(11) Max ran

The logical form of (10) is (10a), and the logical form of (11) is (11a).

(10a) $PAST_{(v,i)}[PROG(run(max))]$

(11a) $PAST_{(v,i)}(run(max))$

We can show that the truth of (10a) in a model M at an index (w,i) entails the truth of (11a) at (w,i) . For suppose that (10a) is true in a model M at (w,i) . Then $g_c(v) = w$, $g_c(t) = i$, and $[PROG(run(max))]$ is true at an index (w,j) where $j < i$; so $[run(max)]^{<M,g>} \in Pr$ (which it does), and there exists a closed interval k such that j is a proper subinterval of k and $run(max)$ is true at (w,k) . By the homogeneity principle satisfied by the framework IQ, if $run(max)$ is true at (w,k) , then it is also true at (w,j) since j is a proper subinterval of k . But $j < i$ and so (11a) is true in the model M at (w,i) . Hence (10) entails (11), as required.

3.2 The Entailments from the Non-Progressive to the Progressive

Let us investigate in this section the entailments from (11) to (10), and (13) to (12). First consider sentence (13), whose formal representation is (13a).

(13) Max won the race

(13a) $PAST_{(v,i)}[win(max,race)]$

Suppose (13a) is true in the model M at (w,i) . Then $g_c(v) = w$, $g_c(t) = i$ and there is an interval $j < i$ such that $win(max,race)$ is true at (w,j) . Suppose that context provides a suitable process to $win(max,race)$ at (w,j) , i.e. this process satisfies the relation R_1 with the denotation of $win(max,race)$. Let $g_c(e)$ be this process in (12a), the logical form of (12).

(12) Max was winning the race

(12a) $PAST_{(v,i)}[PROG[PR_e(win(max,race))]]$

$g_c(e)$ is a suitable process to $\text{win}(\text{max}, \text{race})$ at (w, j) , and so (by relation R_1) since $\text{win}(\text{max}, \text{race})$ is true at (w, j) there exists an interval k whose final bound is j such that $g_c(e)$ is true at (w, k) . Hence by the definition of PR_e , $\text{PR}_e(\text{win}(\text{max}, \text{race}))$ is true at (w, k) , and by the definition of PROG , (12a1) is true in w at the open interior of k .

(12a1) $\text{PROG}[\text{PR}_e(\text{win}(\text{max}, \text{race}))]$

But since $j < i$, $k < i$, and so the open interior of k is earlier than i . Hence (12a) is true at (w, i) . Hence (13) entails (12), modulo context providing a process for Max winning the race.

Problems appear to arise when one investigates whether sentence (11) entails sentence (10).

(11) Max ran

(10) Max was running

One can show that the current analysis does not account for a logical entailment from (11) to (10). I will show this by constructing a model M where (11) is true at an index (w, j) but (10) is false at (w, j) . Let $\text{run}(\text{max})$ be true in the model M only at the index (w, j) and at subintervals of j . Then let $\text{int}(j)$ be the open interior of j . Since $\text{run}(\text{max})$ denotes a proposition from Pr , j must be closed, and so the initial bound k of the interval j is not contained in $\text{int}(j)$ and so k is earlier than $\text{int}(j)$. Furthermore by homogeneity, $\text{run}(\text{max})$ is true at (w, k) (since k is contained in j). Now let us evaluate the truth value of (11a), which is the representation of (11), at $(w, \text{int}(j))$.

(11a) $\text{PAST}_{(v, t)}(\text{run}(\text{max}))$

(11a) is true in the model M at $(w, \text{int}(j))$ if $g_c(v) = w$ and $g_c(t) = \text{int}(j)$ and there is an interval l earlier than $\text{int}(j)$ such that $\text{run}(\text{max})$ is true at (w, l) . Assuming that $g_c(v) = w$ and $g_c(t) = \text{int}(j)$, (11a) is true at $(w, \text{int}(j))$ since k is earlier than $\text{int}(j)$ and $\text{run}(\text{max})$ is true at (w, k) .

However, we can show that (10a), the representation of (10) is *false* in the model M at $(w, \text{int}(j))$.

(10a) $\text{PAST}_{(v, t)}[\text{PROG}(\text{run}(\text{max}))]$

(10a) is true at $(w, \text{int}(j))$ if $g_c(v) = w$ and $g_c(t) = \text{int}(j)$ (these assignments hold by our assumption), and there is an interval l earlier than $\text{int}(j)$ such that $\text{PROG}(\text{run}(\text{max}))$ is true at (w, l) . We will now show that there is no such interval l . Since $\text{run}(\text{max})$ is true in M only at (w, j) and the subintervals

of j , by the definition of PROG, $\text{PROG}(\text{run}(\text{max}))$ is true in M only at $(w, \text{int}(j))$ ($\text{int}(j)$ is the open interior of j) and subintervals of $\text{int}(j)$. Hence there is no interval l earlier than $\text{int}(j)$ such that $\text{PROG}(\text{run}(\text{max}))$ is true at (w, l) and so (10a) is false at $(w, \text{int}(j))$. Thus we have constructed a model M where (11a) is true at $(w, \text{int}(j))$ and (10a) is false at $(w, \text{int}(j))$, and so there is no logical entailment from (11a) to (10a). We are able to construct such a model as a direct result of the fact that $\text{PROG}(\text{run}(\text{max}))$ is true only at the *open interiors* of the interval j at which A is true, and it is not necessarily true at j itself.

In view of the apparent inability to explain why (11) entails (10), the analysis seems to be flawed. However, following Taylor (1977, 1985), one could explain away this flaw by appealing to the distinction between truth and assertability. We appeal to the hypothesis that even though in the above model M (11) is true at the open interval $\text{int}(j)$ in virtue of $\text{run}(\text{max})$ being true at the initial bound of $\text{int}(j)$, one is not in a position to *assert* at the open interval $\text{int}(j)$ that $\text{run}(\text{max})$ was true at the initial bound of $\text{int}(j)$. This hypothesis is motivated by the intuition that an action must go on for an *extended period* of time before one can assert that it is going on; for example, one cannot tell from a snap shot taken of Max at some *moment* m whether Max was running at m , and so one *cannot assert* that $\text{run}(\text{max})$ is true at the moment m *even if* $\text{run}(\text{max})$ is true at m . If one assumes this hypothesis, then one explains that the assertion of (11) entails the assertion of (10).

4 The Progressive and Homogeneity

In chapter 2, I evaluated the *Heterogeneous Strategy* for formulating the classification of aspect. I showed how theories such as Dowty's (Dowty 1979) that adopt the Heterogeneous Strategy provide a heterogeneous analysis of *achievements* (i.e. culminations): the sentence "Max win the race" may be true at an interval i and false at an interval j contained in i . This analysis was supposed to reflect the intuition that not every part of an event where Max wins the race is itself an event where Max wins the race. I suggested that even if the heterogeneous analysis of achievements were to lead to a solution to the imperfective paradox, it would never be able to lead to an account of point adverbials such as "At 3pm" as it appears in sentences (1) and (2).

- (1) Max ran at 3pm
- (2) Max won the race at 3pm

Hence the Heterogeneous Strategy could not lead to both a solution to the imperfective paradox *and* an analysis of "At 3pm".

I have suggested here an alternative to the Heterogeneous Strategy. The interpretation of the classification of aspect presented here is given in the framework of IQ, which maintains the *homogeneity principle* (i) below.

- (i) A primitive untensed sentence A is true at an index (w,i) only if for all subintervals j of i , the sentence is true at (w,j) .

Our formulation of the classification of aspect does not give a heterogeneous analysis of achievements (i.e. culminations). Indeed, such an analysis could not be expressed in IQ given the homogeneity restriction in (i): $\text{win}(\text{max}, \text{race})$ (which represents "Max win the race") cannot be true at the index (w,i) and false at (w,j) where j is contained in i . Furthermore, we have shown that our *homogeneous* formulation of the classification of aspect not only leads to a solution to the imperfective paradox, but it also leads to an adequate semantic account of point adverbials such as "At 3pm" as it appears in sentences (1) and (2). I suggest, therefore, that our homogeneous interpretation of the classification of aspect overcomes the problems that were encountered in the heterogeneous approach.

5 The Progressive and Quantification

As we argued in chapter 5, there is a reading of sentence (3) where universal instantiation fails, for it does not entail sentence (4).

- (3) Max was kissing every girl
(4) Max was kissing Susan

How can one account for this failure?

In chapter 5, I investigated how to account for sentences (3) and (4) in Parsons' (1984) event-based framework and I demonstrated that the analysis fell short. On the other hand, I argued that Dowty's (1979) Eventual Outcome Strategy in defining the progressive was able to account for the failure of universal instantiation with respect to (3). However, in chapter 3, I demonstrated that Dowty's Eventual Outcome semantics for the progressive was inadequate in other respects, and so it would be desirable to find some other way to account for (3).

I claim that one can account for the lack of inference between sentences (3) and (4) in the theory presented here. Let us investigate the truth conditions of (3). A possible representation of (3) is (3a)⁵².

(3a) $PAST_{(v,i)}[PROG[PR_e[(\forall x)(Girl(x) \rightarrow kiss(max,x))]]]$

Sentence (3a) is true in a model M at (w,i) if and only if $g_c(v) = w$, $g_c(t) = i$, and there exists an interval $j < i$ such that (3a1) is true at (w,j).

(3a1) $PROG[PR_e[(\forall x)(Girl(x) \rightarrow kiss(max,x))]]$

This is the case if and only if $(3a2) \in Pr$, and there exists a closed interval k such that j is a proper subinterval of k and (3a2) is true at (w,k).

(3a2) $PR_e[(\forall x)(Girl(x) \rightarrow kiss(max,x))]$

This is the case if and only if (among other things) $g_c(e)$ is true at (w,k). Now $g_c(e)$ can be true at (w,k) without (15) ever being true.

(15) $PROG[PR_{e'}(kiss(max,susan))]$

This is due to the fact that g_c may assign different values to the propositional parameters that appear in (3a) and (15). The value of e in (3a) is the process of Max kissing every girl, and the value of e' in (15) is the process of Max kissing Susan. In general, these are different. If in the model M (15) is never true, then (4a) is false at (w,i).

(4a) $PAST_{(v,i)}[PROG[PR_{e'}(kiss(max,susan))]]$

But (4a) is the logical form of (4), and so (3) does not entail (4), as required.

The failure of the inference from sentence (3) to (4) is accounted for in the analysis presented here, without resorting to a definition of the progressive in terms of eventual outcome. Thus our approach to the imperfective paradox overcomes the problems encountered in Parsons' theory, and since our analysis of the progressive does not adopt the Eventual Outcome Strategy, it also overcomes the problems of that strategy that were described in chapter 3.

⁵² There are other possible representations of (3) that one could entertain, due to the scope ambiguities of the universal quantifier, and the sentential operators PROG and PR_e . I shall not consider these possible representations here.

6 Conclusion

Solving the imperfective paradox consists of two tasks. The first is to represent a semantic distinction between sentences like (11) and sentences like (13).

- (11) Max ran
- (13) Max won the race

The second is to provide a definition of the progressive that is sensitive to this distinction and so results in a solution to the imperfective paradox. I presented an account of the semantic distinction between (11) and (13) in the previous chapter by formulating a classification of aspect in the framework of IQ. In this chapter, I have investigated how one might build on this taxonomy of aspect and thereby solve the imperfective paradox. Our aim was to provide a solution to the imperfective paradox that could fit in a respectable theory of tense and time, and to this end I offered not only a definition of the progressive that solves the imperfective paradox, but I also offered accounts of various temporal modifiers such as "in ten minutes" and "at 3pm".

Two properties of IQ play a central role in the analysis of aspect. The first is the *homogeneity condition* which is fundamental to the framework IQ. Homogeneity plays a crucial role in explaining the entailment between (10) and (11), for example.

- (10) Max was running
- (11) Max ran

The second important feature of the analysis is the role played by *context*. The theory is constructed so that extra-linguistic context determines exactly what process an expression like "Max was building a house" refers to in a particular utterance.

I offered an account of the entailment from (10) to (11), and at the same time showed why no such entailment holds between (12) and (13).

- (12) Max was winning the race
- (13) Max won the race

I also offered an account for why (11) entails (10) and (13) entails (12), and thus I solved the imperfective paradox.

In addition, I accounted for the natural interpretations of sentences (1) and (2).

- (1) Max ran at 3pm
- (2) Max won the race at 3pm

Thus our theory overcomes the inadequacies of the Heterogeneous Strategy (chapter 2) and the current formulations of the Event-based Strategy (chapter 4), for the theories that adopt these strategies could not account for (1) and (2). Moreover in chapter 3, we argued that the Eventual Outcome Strategy lead to a circular definition of the progressive, but our definition of the progressive is not subject to this problem since it does not adopt the Eventual Outcome Strategy.

We were also able to account for the failure of universal instantiation with respect to sentence (3), and so our definition of the progressive overcomes the problems encountered in Parsons' definition of the progressive that we described in chapter 5.

- (3) Max was kissing every girl

In formulating the solution to the imperfective paradox in a homogeneous interval-based framework, we have obtained a solution to the imperfective paradox that transcends the problems encountered in previous theories. We not only provide a solution to the imperfective paradox, but we also provide a satisfactory analysis of point adverbials such as "at 3pm", where Dowty, Taylor and Parsons cannot. We can also provide an explanation of why universal instantiation fails for sentence (3). Thus the solution to the imperfective paradox that we have offered is a significant improvement on previous attempts.

Appendix 1

The Logical Forms of Dowty's Aspectual Classes

The aspectual operators and connectives that form the aspectual classes out of stative predicates are treated as logical constants, and the stative predicates are treated as non-logical constants.

The logical form of statives is as follows:

- 1a. Simple statives: $p_n(a_1, \dots, a_n)$ (e.g. Max knows the answer), where p_n is a n -place stative predicate, and a_1, \dots, a_n are singular terms.
- 1b. Stative Causatives: $[p_m(a_1, \dots, a_m) \text{CAUSE} q_n(b_1, \dots, b_n)]$ (e.g. Max's living nearby causes Mary to prefer this neighbourhood).

The logical form of *activities* is derived from the logical form of statives with the aid of the operator "DO", taking a singular term and a stative as its arguments. This is supposed to capture the intuition that activities are *agentive*; a_1 in the logical form below is the agent:

2. Simple Activities: $\text{DO}(a_1, [p_n(a_1, \dots, a_n)])$, where a_1 is a singular term, and p_n is a stative predicate. (e.g. "Max walks" will have the logical form $[\text{DO}(\text{Max}', \text{in-the-state-of-walking}'(\text{Max}'))]$).

The logical form of *achievements*, given below, captures the intuition that an achievement is the coming about of a particular state of affairs.

3. Simple Achievements: $\text{BECOME}[p_n(a_1, \dots, a_n)]$, where p_n is a stative predicate. (e.g. Max discovers the solution)

The logical form of *accomplishments*, given below, is obtained with the aid of the sentential connective "CAUSE", and the application of the sentential operator "BECOME" to a stative formula. The logical form of accomplishments is supposed to capture the intuition first observed by Kenny, that an accomplishment always involves the coming about of a particular *state of affairs*, as the result of some activity (Kenny 1963).

3. Accomplishments: $[\Psi \text{CAUSE} [\text{BECOME} \Phi]]$, where Φ is a stative sentence. The logical form of Ψ determines whether or not the accomplishment is agentive. For example, if Ψ has the logical form of an activity, then the accomplishment is agentive. e.g. "Max breaks the window" will have the logical form $[[\text{DO}(\text{Max}', \text{breaking-state}'(\text{Max}', \text{the window}'))] \text{CAUSE} [\text{BECOME} (\text{broken}'(\text{the window}))]]$

The logical forms of accomplishments and achievements both include the operator "BECOME". This turns out to be significant when Dowty solves the imperfective paradox.

Although Dowty claims that activities and accomplishments are derived from stative *predicates*, one can see that they are in fact derived from stative *formulas*, since the operators and connectives used to form activities and accomplishments out of statives take formulas as their arguments. Hence Dowty's semantic analysis of the aspectual classes is a formula-based semantics, and this analysis should be separated from the syntactic claims made for verb classes.

Appendix 2

Dowty's Analysis of Tense

Dowty assumes that the simple present tensed sentences are the tenseless sentences in his theory. Hence sentence (1) is an example of a tenseless activity, and sentence (2) is an example of a tenseless accomplishment.

- (1) Max works in the garden
- (2) Max crosses the street

The two-place operator "AT", taking a point of time t and a formula Φ as its arguments, features in the logical form of *tensed* sentences. The truth definition of $[AT(t, \Phi)]$ is given below:

$[AT(t, \Phi)]$ is true at t' if Φ is true at t .

Note that although the truth conditions of $[AT(t, \Phi)]$ are given relative to a point of time t' , there is no relationship between t' and t . So $[AT(t, \Phi)]$ is an *eternal* sentence; it is true at all points in time or at none. In particular, it is not affected in truth value by affixing any further tense operator.

The way in which Dowty represents tense is as follows: If Φ is a formula, then the logical form of the past tensed form of Φ is (3).

- (3) $(\exists t)(\text{Past}(t) \ \& \ AT(t, \Phi))$

The truth conditions of (3) in words are the following: (3) is true at t_1 if and only if there exists a point in time t which is in the past - i.e. before t_1 - and Φ is true at t . The future tense is represented in a similar manner.

Appendix 3

Taylor's Revised Postulates for E and K-verbs

Postulate 5

If P^n is an E-predicate, then it meets the following condition:

$$V^n t \rightarrow \text{Per}(t) \ \& \ (\exists a)(\text{Max}_V(a) \ \& \ t \sqsubseteq a \ \& \ (\exists b)(\text{Min}_V(b) \ \& \ b \sqsubseteq a) \ \& \ (\forall c)(c \sqsubset a \rightarrow (\exists b)(\text{Min}_V(b) \ \& \ b \sqsubseteq c)))$$

Postulate 6

If P^n is a K-predicate, then it meets the following condition:

$$V^n t \rightarrow \text{Per}(t) \ \& \ (\exists a)(\text{Max}_V(a) \ \& \ t \sqsubseteq a \ \& \ (\exists b)(\text{Min}_V(b) \ \& \ b \sqsubseteq a) \ \& \ (\forall c)((\text{Min}_V(c) \ \& \ c \sqsubset a) \rightarrow (\exists d)(c \sqsubset d \ \& \ d \sqsubset a \ \& \ \neg V^n d)))$$

The definitions of $\text{Max}(t,z)$ and $\text{Min}(t,z)$ are given below:

(D 1) t is *maximal with respect to a set z of times*

$$\text{Max}(t,z) \iff (t \in z \ \& \ \neg(\exists t')(t \sqsubset t' \ \& \ t' \in z))$$

(D 2) t is *minimal with respect to a set z of times*

$$\text{Min}(t,z) \iff (t \in z \ \& \ \neg(\exists t')(t' \sqsubset t \ \& \ t' \in z))$$

Appendix 4

The Possible Representations of "Max is kissing every girl" in Dowty's Theory

We will now show that (22b), (22c) and (22e) cannot explain that the rule of universal instantiation fails in the case of (22), and so they are inadequate representations of (22).

- (22) Max is kissing every girl
 (22b) $(\forall x)[\text{PROG} [\text{girl}'(x) \rightarrow [\text{BECOME kissed}'(x, \text{max}')]]]$
 (22c) $(\forall x)(\text{girl}'(x) \rightarrow [\text{PROG} [\text{BECOME kissed}'(x, \text{max}')]]]$
 (22e) $(\forall x)[\text{PROG} [\text{BECOME} (\text{girl}'(x) \rightarrow \text{kissed}'(x, \text{max}'))]]$

I start with (22b).

(22b) is true at $\langle I, w \rangle$ with respect to M and g just in case for all g' exactly like g except possibly in the value assigned to x , formula (22b1) is true at $\langle I, w \rangle$ with respect to M and g' ,

- (22b1) $[\text{PROG} (\text{girl}'(x) \rightarrow [\text{BECOME kissed}'(x, \text{max}')])]$

just in case there is an interval I' containing I such that for all $w' \in \text{Inr}(\langle I, w \rangle)$, (22b2) is true at $\langle I', w' \rangle$,

- (22b2) $\text{girl}'(x) \rightarrow [\text{BECOME kissed}'(x, \text{max}')]]$

just in case either (22b3) or (22b4) is true at $\langle I', w' \rangle$.

- (22b3) $\neg \text{girl}'(x)$
 (22b4) $[\text{BECOME kissed}'(x, \text{max}')]]$

Suppose that the formula (22b) is true at $\langle I, w \rangle$ with respect to M and g . Then the formula (24) must be true at $\langle I', w' \rangle$ at some interval I' and for all $w' \in \text{Inr}(\langle I, w \rangle)$ (we assume that $\text{girl}'(\text{susan}')$ is true).

- (24) $[\text{BECOME kissed}'(\text{susan}', \text{max}')]]$

Hence by the definition of PROG, (23a), which is the representation of (23), is true at $\langle I, w \rangle$ with respect to M and g .

- (23) Max was kissing Susan
 (23a) $\text{PROG} [\text{BECOME kissed}'(\text{susan}', \text{max}^*)]$

Hence we have an entailment from (22b) to (23a). But we do not wish to capture such an entailment, and therefore (22b) cannot explain that universal instantiation fails with respect to (22).

Now consider (22c). (22c) is true at an index $\langle I, w \rangle$ with respect to model M and value assignment g if and only if for every g' exactly like g except possibly in the value assigned to x , (22c1) is true at $\langle I, w \rangle$ with respect to M and g' .

- (22c1) $\text{girl}'(x) \rightarrow [\text{PROG} [\text{BECOME kissed}'(x, \text{max}^*)]]$

Suppose that (22c) is true at $\langle I, w \rangle$ with respect to M and g . Then the formula (23a) must be true at $\langle I, w \rangle$ with respect to M and all the g' like g except possibly in the value assigned to x (we assume that $\text{girl}'(\text{susan}^*)$ is true). Hence (23a) is true at $\langle I, w \rangle$ with respect to M and g . Hence (22c) entails (23a). Therefore (22c) cannot explain that universal instantiation fails with respect to (22).

Now let us consider the truth conditions of (22e). (22e) is true at $\langle I, w \rangle$ with respect to a model M and value assignment g if and only if for g' exactly like g except possibly in the value assigned to x , formula (22e1) is true at $\langle I, w \rangle$ with respect to M and g' ,

- (22e1) $[\text{PROG} [\text{BECOME} (\text{girl}'(x) \rightarrow \text{kissed}'(x, \text{max}^*))]]$

if and only if there is an interval I' containing I such that I is not a final subinterval of I' and for all $w' \in \text{Inr}(\langle I, w \rangle)$, formula (22e2) is true at $\langle I', w' \rangle$,

- (22e2) $[\text{BECOME} (\text{girl}'(x) \rightarrow \text{kissed}'(x, \text{max}^*))]$

if and only if there exists an interval J containing the initial bound of I' such that (22e3) is true at $\langle J, w' \rangle$, and there is an interval K containing the final bound of I' such that either (22e4) or (22e5) are true at $\langle K, w' \rangle$.

- (22e3) $\text{girl}'(x) \ \& \ \neg \text{kissed}'(x, \text{max}^*)$
 (22e4) $\neg \text{girl}'(x)$
 (22e5) $\text{kissed}'(x, \text{max}^*)$

Suppose that (22e) is true at $\langle I, w \rangle$ with respect to M and g . Suppose furthermore that $\text{girl}'(\text{susan})$ is true in w and in the $w' \in \text{Inr}(\langle I, w \rangle)$. Since (22e) is true at $\langle I, w \rangle$, there exists an interval J containing the initial bound of I' such that (25) is true at $\langle J, w' \rangle$ with respect to M and g .

(25) $\text{girl}'(\text{susan}) \ \& \ \neg \text{kissed}'(\text{susan}, \text{max})$

Furthermore, there is an interval K containing the final bound of I' such that (26) is true at $\langle K, w' \rangle$ with respect to M and g .

(26) $\text{kissed}'(\text{susan}, \text{max})$

Hence by the definition of BECOME, (24) is true at $\langle I', w' \rangle$ for all $w' \in \text{Inr}(\langle I, w \rangle)$ with respect to M and g .

(24) $[\text{BECOME } \text{kissed}'(\text{susan}, \text{max})]$

So by the truth conditions of the progressive, (23a) is true at $\langle I, w \rangle$ with respect to M and g . So (22e) entails (23a), and therefore (22e) cannot explain that universal instantiation fails with respect to (22).

Appendix 5

The Truth Definitions in IQ

Given an IQ-interpretation $\langle M, g \rangle$, the denotation of a well-formed expression β is defined recursively in the following way. We let $[[\beta]]^{\langle M, g \rangle}(w, i)$ be the denotation of β relative to the IQ-interpretation $\langle M, g \rangle$ with respect to the index (w, i) belonging to $W \times I$.

- (a) Where β is a variable, $[[\beta]]^{\langle M, g \rangle}(w, i) = g(\beta)$.
- (b) Where β is either a name constant or a predicate constant, $[[\beta]]^{\langle M, g \rangle}(w, i) = f(b)(w, i)$.
- (c) Where β is a parameter, $[[\beta]]^{\langle M, g \rangle}(w, i) = g_c(\beta)$.
- (d) Where β is an atomic wff $p^n(d_1, \dots, d_n)$, $[[\beta]]^{\langle M, g \rangle}(w, i) =$
 1 if $\langle [[d_1]]^{\langle M, g \rangle}(w, i), \dots, [[d_n]]^{\langle M, g \rangle}(w, i) \rangle$ belongs to $[[p^n]]^{\langle M, g \rangle}(w, j)$,
 0 if $\langle [[d_1]]^{\langle M, g \rangle}(w, i), \dots, [[d_n]]^{\langle M, g \rangle}(w, i) \rangle$ does not belong to $[[p^n]]^{\langle M, g \rangle}(w, j)$,
 u if $[[d_i]]^{\langle M, g \rangle}(w, i)$ is undefined for any i where $1 \leq i \leq n$ or $[[p^n]]^{\langle M, g \rangle}(w, i)$ is undefined.
- (e) Where β is a wff $(A \leftrightarrow B)$, $[[\beta]]^{\langle M, g \rangle}(w, i)$ is
 1 if $[[A]]^{\langle M, g \rangle}(w, i) = [[B]]^{\langle M, g \rangle}(w, i) = 1$ or $[[A]]^{\langle M, g \rangle}(w, i) = [[B]]^{\langle M, g \rangle}(w, i) = 0$,
 0 if $[[A]]^{\langle M, g \rangle}(w, i) = 1$ and $[[B]]^{\langle M, g \rangle}(w, i) = 0$ or $[[A]]^{\langle M, g \rangle}(w, i) = 0$ and $[[B]]^{\langle M, g \rangle}(w, i) = 1$
 u otherwise.
- (f) Where β is a wff $\exists x A$ with the individual variable x , $[[\beta]]^{\langle M, g \rangle}(w, i)$ is
 1 if $[[A]]^{\langle M, g(x, e) \rangle}(w, i) = 1$ for some e belonging to D ,
 0 if $[[A]]^{\langle M, g(x, e) \rangle}(w, i) = 0$ for all e belonging to D ,
 u otherwise.
- (k) Where β is a wff $\forall x A$ with the individual variable x , $[[\beta]]^{\langle M, g \rangle}(w, i)$ is
 1 if $[[A]]^{\langle M, g(x, e) \rangle}(w, i) = 1$ for all e belonging to D ,
 0 if $[[A]]^{\langle M, g(x, e) \rangle}(w, i) = 0$ for some e belonging to D ,
 u otherwise.

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